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THE EVOLUTION OF FLOWERS.

By GRANT ALLEN.

IV.—SIDE BRANCHES.

BEFORE we finish with the simplest group of monocotyledons, the Alismas, and proceed to their more developed relations, the true lilies, we must stop awhile to examine a couple of divergent species which present some singular features of their own, showing them to be distinct lateral offsets from the primitive water-plantain ancestor.

The common arrowhead (*Sagittaria sagittifolia*) might fairly claim, for several reasons, to represent the original monocotyledon even more closely than Alisma, were it not for one particular, which I shall mention in due course. It is a pretty and stately perennial, with glossy green, arrow-shaped leaves, rising high out of the water, and bearing a tall bunch of large and striking snow-white flowers. As in Alisma, there are three outer green sepals and three inner and larger white petals. The stamens, instead of being only six in number, are very numerous; and as this is also the case in the buttercups, the simplest and most primitive dicotyledons, we may fairly accept it as a common sign of great antiquity. The carpels are also numerous, small, and one-seeded. All these points show the arrowhead to be at least as primitive in general type as the water-plantain, while the large number of the stamens and carpels seems to betoken a still earlier and simpler organisation.

Why, then, should we not take the rare arrowhead rather than its commoner ally, the Alisma, as the best living representative of the general ancestor from whom the whole existing lily stock is ultimately descended? Simply for this reason; the Sagittarias have all distinct male and female flowers, while in the Alismas, as in the lilies and most other advanced monocotyledons, the stamens and pistils are both found together in the same blossoms. In the arrowhead, the upper flowers are usually males, that is to say, possess stamens alone, while the lower ones are females, with nothing in their middle but a group of very numerous carpels. The flowers, originally hermaphrodite (that is to say, with both stamens and carpels), have become differentiated into two distinct sexes, males above and females below, by the abortion or gradual disappearance of the carpels in one case and the stamens in the other.

Why is this? Well, the change is only one out of the many means commonly adopted by flowers to ensure cross-fertilisation. We may conclude that at some early time some very primitive Alisma-like plant showed some tendency to produce more stamens on some of its blossoms, and more carpels on others. This is a tendency which often occurs in many plants, and as a familiar case we may take the strawberry, which everywhere, but especially in America, has a constant leaning towards the separation of its sexes not only on different flowers, but even on different plants. Now, whenever this tendency is set up, it is pretty sure to prove advantageous to the species (unless, indeed, it interferes with some other and better device for cross-fertilisation) because it renders it absolutely impossible that any blossom can be impregnated in the undesirable fashion with pollen from its own stamens. Accordingly,

Sagittaria sagittifolia.

the arrowheads have kept this useful feature ever since, and so have successfully avoided self-fertilisation with its usual concomitant of degeneracy and final extinction. Their chief insect allies are flies of the same sort as those which visit the true Alismas.

Why, again, are the male flowers at the top, while the females are below? For this reason. The flies, like most other insects, always begin their visits to a spike of blossoms at the bottom and proceed slowly upward. In this way they arrive at the female flowers first, and dust them over with pollen from the plant they last visited. Then, as they rise towards the top, they reach the male flowers, and gather from them a fresh store of pollen, which they carry away to the next bunch. By such a simple device nature ensures the fertilisation of each blossom, not merely from another flower, but also from another plant. That is cross-fertilisation in its truest and purest form, and it produces the stoutest and healthiest seedlings of all.

Once more, why doesn't the pollen from the male flowers fall down upon and fertilise the females below? Would it not have been better to put the females on top, so as to

avoid this chance? No, because the flowers open from below upward, and so the females ripen first. They will, therefore, in all probability, get impregnated before the stamens begin to shed their golden dust. But if they don't, then the pollen will fall upon them in due course; and this modified form of cross-fertilisation from the flowers of the same stem is better far than no fertilisation at all, and consequent absolute sterility.

Arrowhead, then, is clearly a close representative of a very primitive form; but it fails to be the closest representative, because in it the pistils of some flowers and the stamens of others have become abortive, and this could not have been the case in the ancestor of the fully hermaphrodite lilies and amaryllids. In short, arrowhead is a very low but still specialised form.

Butomus umbellatus.

Our last British Alismaceous plant is the beautiful rose-coloured flowering rush (*Butomus umbellatus*), whose tall, straight stem and handsome umbel of large bright flowers rise so proudly above the ponds and backwaters of our southern counties. The flowering rush shows some distinct signs of advance in the same general direction as that taken independently by the lilies. The distinction between sepals and petals has here nearly died away, for all six perianth pieces are nearly equally large and brightly coloured, and all equally take part in the attractive display. Nevertheless, if you look carefully you will see that the three outer ones still retain marks of their original character as sepals, for they are not quite so large or so petal-like in structure as the three inner, and they have acted as a covering to the true petals while in the bud. This similarity between petals and sepals is even more marked in the lilies, where the distinction of the two can scarcely ever be perceived in anything else save arrangement on the stem. The stamens are nine in number—three whorls of three each, and the carpels are six, as in the damasonium and the sea arrow grass. But in each carpel—and this is an important point—there are many seeds, instead of one or two only; and we shall find that a similar advance in such respect is almost universal in the lower lilies.

The large rose-coloured flowers of the Butomus attract bees and other higher insects, by whose aid they have no doubt been developed. These trustworthy allies enable it to get fertilised very securely, and so to lessen the number of its carpels to six. But each carpel contains many seeds, and so the plant can afford to do with comparatively few flowers, far fewer than the Alisma or the Triglochins. It has learnt to substitute efficiency for large numbers. This, also, is a step in advance in the direction of the true lilies.

Finally, observe the bracts or small leaves at the base of the bunch of flowers, put there to sheathe them from harm while they are young buds, and to protect them both from cold and from injurious insects. Those bracts are the first indication of what is called a spathe, which becomes so important and conspicuous in several of the higher lily-like plants. Among the true lilies, we get it very marked in the garlics and onions. Among the Amaryllids it is almost equally noticeable in the narcissus and daffodil. Among the palms it assumes the form of a large sheet, completely enclosing the whole mass of blossom. And last of all, in the very degraded arums, it forms the hood or sheath, which is all that can be seen externally of the flower, and within which the real blossoms cluster closely on a long spike or spadix, almost entirely hidden within the large coloured spathe. It is interesting thus to note the first faint beginnings of what rises at last to be so very conspicuous and remarkable an organ. As it occurs in the flowering rush, the spathe is nothing more than three small thin bracts, that is to say, very reduced and simple stem-leaves.

THE MYSTERY OF GRAVITY.

BY not a few the idea is erroneously entertained that when Newton established the law of gravity, he had explained the movements of the heavenly bodies. "Nature, and Nature's laws lay hid in night," the poet sings, and then with poetical truth he adds, "God said let Newton be, and all was light." Such, however, was not Newton's own opinion. He saw clearly that behind the law which he had discovered, beyond the veil which he had removed, there was a mystery greater and more solemn than the mystery of those movements in the heavens and on the earth which in a sense he might be said to have explained.

It was a fancy of Kepler's in his earlier days, that the planets are carried along their orbits by angels, moving according to appointed laws, so that although the paths of the planets and their movements in those paths may be described in mathematical terms, yet they are to some degree the result of voluntary action,—a disobedient angel might carry his planet the wrong way if he so willed, unless his wilful disobedience were instantly checked by a superior power (not necessarily the supremest). Newton showed that these intermediary agents are not necessary; that the laws of planetary motion are themselves but parts of a higher and more widely ranging law, the law of universal attraction. But even as Kepler could not explain why the laws which bear his name exist, so Newton who could explain them as results of the law of attraction, could not explain why that law itself exists.

Newton's own words are worth considering by those who imagine he had explained the whole mystery of celestial movements:—"Hitherto," he says, "we have explained the phenomena of the heavens and of our sea by the power of gravity, but have not assigned the cause of this power. This is certain, that it must proceed from a cause that penetrates to the very centres of the sun and planets, without suffering the least diminution of its force; that operates not according to the quantity of the surfaces of the particles upon which it acts (as mechanical causes

used to do) but according to the quantity of the solid matter which they contain, and propagates its virtue on all sides to immense distances, decreasing always in the duplicate proportion of the distances. Gravitation towards the sun is made up out of the gravitations towards the several particles of which the body of the sun is composed; and in receding from the sun decreases accurately in the duplicate proportion of the distances as far as the orb of Saturn—nay, even to the remotest aphelions of the comets (he gives reasons for this belief which can be applied in our own time, even to the whole space over which the range of the telescope has been extended). But hitherto I have not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses" (*hypotheses non fingo*). He explains what he means by hypotheses, in words showing that he used the term in a somewhat restricted sense, for unquestionably in our own time a hypothesis is generally understood to mean a proposition suggested as a possible way of explaining phenomena, and therefore in some degree deduced from them. Newton however defines a hypothesis as "whatever is not deduced from the phenomena"; and hypotheses, he proceeds, "whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy, in which particular propositions are inferred from the phenomena and afterwards rendered general by induction. In this way were discovered the impenetrability, the mobility, and the impulsive force of bodies, and the laws of motion and of gravitation. *To us it is enough* that gravity does really exist, and act according to the laws which we have explained and abundantly serves to account for all the motions of the celestial bodies, and of our sea."

THE EXTRAORDINARY SUNSETS.

BY A. COWPER RANYARD.

(*Continued from page* 156.)

THERE seems to be some evidence to show that brilliant sunset phenomena have been observed on former occasions in connection with volcanic eruptions. Gilbert White, of Selborne, in one of his letters to the Hon. Danes Barrington, describes "the amazing and portentous phenomena" observed in the summer of 1783. "The sun at noon looked as blank as a clouded moon, and shed a rust-coloured ferruginous light on the ground, particularly lurid and blood-coloured at rising and setting. The country people began to look with a superstitious awe at the red, lowering aspect of the sun; and, indeed, there was reason for the most enlightened person to be apprehensive, for all the while Calabria and part of Sicily were torn and convulsed with earthquakes, and about that juncture a volcano sprang out of the sea off the coast of Norway." There are many references to the great alarm which was caused all over Europe by the appearance of a "red fog," which lasted during the whole of the summer of 1783. Lalande ascribed it to the natural effect of a hot sun succeeding on a long period of heavy rains. Cowper refers to it in "The Task," Book II., lines 53–65, which were written in the autumn of 1783, and speaks of the eruptions with the unusual appearance of the sky and the dim and sickly appearance of the sun. He also refers to extraordinary winds and tidal waves.

> When were the winds
> Let slip with such a warrant to destroy?
> When did the waves so haughtily o'erleap
> Their ancient barriers, deluging the dry?
> Fires from beneath, and meteors from above,
> Portentous, unexampled, unexplained,
> Have kindled beacons in the sky; and the old
> And crazy earth has had her shaking fits
> More frequent, and foregone her usual rest.
> Is it a time to wrangle, when the props
> And pillars of our planet seem to fail,
> And nature with a dim and sickly eye
> To wait the close of all?

Mrs. Somerville, in her "Physical Geography," traces the origin of these atmospheric phenomena of 1783 to the great eruption of Skaptar Jokul, which broke out on May 8, and continued till the end of August, sending forth lava and clouds of dust, which spread over the whole of Europe. Sir Charles Lyell, in his "Principles of Geology," Vol I., p. 372, speaks of this eruption as "more tremendous than any recorded in the modern annals of Iceland." Some idea of the magnitude of the eruption may be derived from a calculation made by Sir John Herschel, mentioned in his "Physical Geography," p. 111, where he states that twenty-one cubic miles of lava were ejected—a quantity equal in volume to the water poured by the Nile into the sea in a year.

Professor Michie Smith, in a letter published in *Nature* of Nov. 8, 1883, after describing the blue sun recently seen in India, says that a similar blue appearance of the sun was observed over Europe and America in 1831. He rejects the Krakatoa theory, as not accounting for the appearances observed in India, and he does not seem to have been aware of the eruption in the Mediterranean which, in July, 1831, gave rise to Graham's Island. Extraordinary sunsets were observed in that year, as appears from a letter of Mrs. E. M. Pitman, published in *Nature* of Dec. 13. She says: "I remember how splendid the colouring of the sky was at Malta, after sunset, in the year that 'Graham's Island' appeared. The great beauty of the sunsets we have been having have forcibly reminded me of the colouring I saw so many years since at Malta."

This evidence is not conclusive, but it lends some probability to the assumption that the recent sunset phenomena are connected with the great Krakatoa eruption. On June 30, 1861, the earth passed through the tail of the great comet of that year, and must have swept clean of dust a cylindrical area 8,000 miles in diameter, and probably 400,000 or 500,000 miles in length, but there were no sunsets which attracted special attention during the following months of that year.

It cannot be doubted that the earth did pass through the tail of the comet of 1861. Mr. Hind predicted that such a transit would take place on the evening of June 30; and the Rev. T. W. Webb, of Hardwick, without knowing of Mr. Hind's prediction, noticed on the evening of June 30 a number of long, faint streamers pointing to the nucleus of the comet. As he watched them, they slowly closed up like a fan. An account of Mr. Webb's observation is given in the *Monthly Notices*, Vol. XXII., p. 311, and leaves no room to doubt that the faint streamers which he saw stretching across the heavens were streams of rather denser matter connected with the nucleus, and that the earth was at the time passing through the tail, as a fly might pass through the feathers of a shuttlecock. Mr. George Williams, of Liverpool, also noticed the rapid angular motion of two of the streamers, while Mr. Tebbutt, in Australia, who was observing on the morning of July 1, 1861—*i.e.*, really in the afternoon before sunset of our English June 30—noticed the widening out of the branches of the tail, showing that the actual passage of the earth through the central part of the tail must have taken place about sunset on the evening of our June 30.

I was aware of this transit of the earth through the tail of the comet of 1861, when I suggested that the

passage of the earth through a cloud of meteoric dust might have given rise to the recent sunset phenomena, but I thought that the matter of a comet's tail is probably too imponderable to cause any sensible effect in the condition of the earth's atmosphere.

If the earth has recently passed through a cloud of meteoric particles, they cannot have been comparable in size with the fragments which on entering the air give rise to the meteors which are seen with the naked eye. Millions of such meteors entering the air at once would cause the heavens to appear all ablaze, and even if only two or three were encountered in every cubic mile of space, the resulting phenomena could not have escaped attention on clear nights. But millions of such little meteors as are only seen with the telescope might enter the atmosphere without increasing the light of the heavens sufficiently to attract attention. We know nothing definitely as to the size of the particles which give rise to meteors which do not reach the earth's surface, or as to the amount of matter melted and driven off from the surface of meteors which do reach the earth's surface.

An ordinary house candle seen at the distance of a mile appears much brighter than a sixth magnitude star, and a small morsel of platinum wire raised to a white incandescent heat, not sufficient to melt the platinum, gives more light than such a candle. The meteors which appear and vanish in the upper air, are no doubt, raised to as high a temperature as the platinum wire, or they would not be broken up and driven into vapour in a few seconds. But it does not necessarily follow that a mass which would give the light of a sixth magnitude star if seen at the distance of a mile, as one side of it is heated and driven into vapour in its passage through the air, is smaller than the minute piece of platinum wire which gives rise to the brilliant light in the laboratory. Such an incandescent mass seen at a hundred miles distance would give one ten-thousandth part of the light of the same mass seen at a mile distant. It is, therefore, conceivable that large quantities of matter may come into the air without being perceived by us.

Observations show that the larger meteors usually become incandescent and attract attention before they have entered the air to a depth of 70 miles above the sea level. It is evident that the resistance of the atmosphere must tend to break up small particles more suddenly than large particles. For other things being similar, the resistance experienced varies as the surface, that is, as the square of the diameter of the moving particle, while the momentum varies as the weight or cube of the diameter. In the case of particles which do not reach the earth's surface, the whole of the momentum is converted into heat, and owing to the relatively larger surface of small particles, the heat will be more rapidly developed the smaller the particle. When a meteoric particle first encounters resistance in the outer air, its temperature is probably many degrees below zero. As the resistance increases, its temperature must rise until the surface of the particle becomes white hot, unless the particle is composed of material which can be driven into vapour at a temperature less than a white heat, or unless the resistance increases so slowly that the radiation of heat from the particle into space, and the loss of heat due to contact with she cold air, more than counterbalances the increase of temperature due to loss of momentum. If the smaller meteoric particles consist of materials similar to the meteoric masses which have been known to reach the earth's surface, the first supposition may be neglected. It will hardly be contended that particles moving with velocities comparable with the earth's velocity in space take so long to enter the earth's atmosphere to a depth where the resistance would cause them to become incandescent that they have time to radiate away the greater part of the heat, which, if developed suddenly, would have driven them into vapour, and it seems hardly probable that contact with the cold air would cause such a loss of heat in a few seconds. It should be remembered that the weight of air encountered by a meteoric mass increases relatively to the weight of the meteoric mass as its diameter decreases. The temperature of the air encountered has probably less to do with the resulting temperature of the meteoric mass than the velocity with which the air is encountered. It is evident that the larger masses become white hot from the blows they receive from the particles of the intensely cold air, and it seems reasonable to suppose that the greater the number of blows delivered on a given mass, in a given time, the greater will be the heat to which the meteoric mass is raised.

The chief part of the light emitted by a meteor is emitted between the level where it is raised to a temperature of white incandescence and the level where the last portion of the solid or melted nucleus is driven into vapour. It is evident that the smaller the meteor the higher will be the level at which the resistance of the air would first raise it to incandescence, and the more rapidly will it pass to the level where the last portion is driven into vapour. If it is broken into fragments by the pressure caused by its motion through the atmosphere, or by expansion due to heat, the area of the resisting surface will be increased, and the solid or liquid parts will be still more quickly converted into vapour. It seems, therefore, improbable that small meteoric particles, which enter the air with velocities comparable with the earth's velocity, should reach the surface without being vaporised. The vapour of iron would, no doubt, rapidly be precipitated, and it would probably reach the surface in the form of very minute particles of black oxide.

(*To be continued.*)

GHOSTS AND GOBLINS.

By Richard A. Proctor.

(*Continued from page* 122.)

IT would be easy to fill page after page with the details of the various ideas entertained about ghosts, goblins, and demons. Such ideas extend not only to the appearance of such beings, their apparel, appurtenances, and so on, but to the noises which they make either of themselves or by means of various supernatural objects which they are supposed to carry about with them. Thus—

> The sheeted dead
> Did *squeak* and gibber in the streets of Rome
> A little ere the mightiest Julius fell.

And it is to be noted that as ghosts commonly show no face, so, few have been known to speak with full voice. This may be because the noises heard at the hours when ghosts are seen are not such as can be by any possibility mistaken for the human voice in its ordinary tones, while nevertheless an excited imagination can frame words out of the strange sounds which can be heard in almost every house in the stillness of night. This also serves to account for the notion that ghosts can clank chains, or make other dismal noises. Sounds heard at night are highly deceptive; a small noise close by is taken for a loud noise at a distance (not necessarily a very great distance); and a noise made by objects of one kind will be mistaken for noises made by objects of a different kind altogether. A friend of mine

told me he had been disturbed two nights running by a sound as of an army tramping down a road which passed some 200 yards from his house; he found the third night (I had suggested an experimental test as to the place whence the sound came) that the noise was produced by a clock in the next house, the clock having been newly placed against the party wall. We all know Carlyle's story of the ghostly voice heard each evening by a low-spirited man—a voice as of one, in like doleful dumps, proclaiming "once I was hap-hap-happy, but now I am meeserable,"—and how the ghost resolved itself into a rusty kitchen-jack. There is a case of a lady who began to think herself the victim of some delusion, and perhaps threatened by approaching illness, because each night, about a quarter-of-an-hour after she had gone to bed, she heard a hideous din in the neighbourhood of her house, or else (she was uncertain which) in some distant room. The noise was in reality the slightest possible creak (within a few feet of her pillow, however), and produced by the door of a wardrobe which she closed every night just before getting into bed. This door, about a quarter-of-an-hour after being closed, recovered its position of rest, slightly beyond which it had been pushed in closing. In another case the crawling of a snail across a window produced sounds which were mistaken for the strains of loud but distant music.

It is, perhaps, not going too far to say that our modern spirits, who deal in noise-making as well as in furniture-tilting (of yet more marvellous feats I say nothing), are not unacquainted with the means by which the ear may be deceived as in the cases just considered. Some sounds said to be heard during dark *séances* suggest the suspicion.

It will be seen that the opinion to which I incline—as the best and perhaps only natural interpretation of events supposed to be supernatural—is that real sights and sounds are modified by the imagination, either excited or diseased, into seemingly supernatural occurrences. It does not seem to me likely that in any large proportion of recorded (and presumably veracious) ghost stories, there has been an actual phantom of the brain. Such phantoms are sometimes seen, no doubt, and unreal voices are sometimes heard; but the condition of the brain which leads to such effects must be regarded as altogether exceptional. Certainly it is not common. On the contrary, the play of fancy by which images are formed from objects in no way connected with the picture raised in the mind is a common phenomenon. Although some minds possess the faculty more than others, few actually want it. I suppose there is not one person in a thousand who cannot see "faces in the fire," for instance, though to some the pictures so produced are much more vivid than to others. Dickens tells us that in travelling through a cleared region in America at night, the trees by the roadside seemed to assume the most startling resemblance to different objects—now an old man sitting in a chair, now a funeral urn, and so on. Doubtless, not every traveller along the road under the same circumstances would have found so many fanciful tree-pictures formed for him, or perhaps any formed so distinctly as did Dickens, with his lively imagination and wealth of mind-images. Yet probably very few persons travel along a tree-covered region in the deeper dusk of evening without fancying that the trees shape themselves into strange forms of living or inanimate objects.

But the important point to be noticed is that when the mind is deeply occupied with particular thoughts the imagination is more likely to conjure up pictures connected with those thoughts than such random pictures as are formed when the mind is not so preoccupied. If we admit this—and I conceive that there can be very little doubt on the point—we can dispose very readily of the argument from coincidence, advanced by those who believe that the spirits of the dead sometimes come visibly into the presence of the living. I present this argument as urged in an analogous case (that of visions at the moment of death) by a late eminent mathematician, whose belief in the possibility at least of many things which are commonly regarded as superstitions was so well known that no apology need here be made for touching on the subject. After speaking on the general subject of coincidences, De Morgan thus, in language less simple than he commonly employs, presents the argument for spectral apparitions (at the moment of the death of the person so appearing):—"The great *ghost-paradox* and its theory of coincidence will rise to the surface in the mind of every one. But the use of the word *coincidence* is here at variance with its common meaning. When A is constantly happening, and also B, the occurrence of A and B at the same moment is the mere coincidence which may be casualty." (That is, this is a coincidence of the common kind.) "But the case before us is that A is constantly happening" (*here* by A, De Morgan means a death, as he explains further on, but the explanation should come in at this point) "while B" (the spectral appearance of the person who dies), "when it does happen, almost always happens with A, and very rarely without it. That is to say, such is the phenomenon asserted; and all who rationally refer it to casualty affirm that B is happening very often as well as A, but that it is not thought worthy of being recorded except when A is simultaneous." I must venture to express my dissent from this statement; it seems to me incredible that any person would, as De Morgan asserts, *rationally* affirm that spectral appearances are "very often" seen. "In talking of this subject," he proceeds, "it is necessary to put out of the question all who play fast and loose with their secret convictions: these had better give as a reason, when they feel internal pressure for explanation, that there is no weathercock at Kilve: this would do for all cases. But persons of real inquiry will see that, first, experience does not bear out the asserted frequency of the spectre, without the alleged coincidence of death; and secondly that if the crowd of purely casual spectres were so great that it is no wonder that now and then the person should have died at or near the moment, we ought to expect a much larger proportion of cases in which the spectre should come at the moment of the death of one or another of all the cluster who are closely connected with the original of the spectre." (This is not very distinct: any wrong spectre, with or without close connection with any particular moribund, would seem to serve De Morgan's purpose in this argument equally well. He appears to insist, however, on the fact—undoubtedly such—that if spectres were commonly appearing, without reference to the deaths of individuals, cases would happen pretty frequently where a spectre appeared which was not that of a person then dying, but of some near relative. I feel by no means sure, however, that I have rightly caught De Morgan's meaning.) "But this," he proceeds, "is, we know, almost without example. It remains then, for all who speculate at all, to look upon the asserted phenomenon, think what they may of it, the thing which is to be explained, as a *connection* in time of the death, and the simultaneous appearance of the dead. Any person the least used to the theory of probabilities will see that purely casual coincidence, the *wrong spectre* being comparatively so rare that it may be said never to occur, is not within the rational field of possibility."

I have quoted this argument because it applies equally well to the case of spectral appearances after death. The right spectre is always seen, so far as is known, and it

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appears always on a suitable occasion (at least, an occasion as nearly suitable as the case permits).

It must be admitted, however, that this explanation does not cover the facts of all ghost stories. There are some narratives which, if accepted in all their details, appear to admit of no explanation other than that which refers the events described to supernatural causes. But it must not be forgotten that these narratives have come in every instance from believers in ghosts and spirits; and without questioning the veracity of particular narrators, we may yet not unfairly point out that it is not absolutely impossible that at some stage or other, either in the events related or in the handing down of the story, some degree of deception may have come in. Tricks *have* been played in these matters, beyond all possibility of question. Untruths *have* been told also. The person who doubts a narrative of the marvellous is not bound to say *where* he suspects that some mistake has been made, some deception practised, some statement made which is not strictly veracious. He may not wish to say, or he may even be very far from believing, that the narrator is a trifle foolish or not quite honest. He may put faith in the persons cited as authorities for the narrative; and he may even carry his faith, as well in the sense as in the honesty of the persons concerned, a step or two farther. Yet he may still find room for doubt. Or again, he may have very little faith, and very ample room for doubt, and yet may have valid reasons for not wishing to state as much. Persons who tell marvellous stories ought not to press too earnestly for their auditor's opinion. It is neither fair nor wise.

(*To be continued.*)

SCINTILLATION.

By a Fellow of the Royal Astronomical Society.

FROM the time of the early compilers of that curious Chinese astronomical farrago, the Ma-twan-lin, through that of Aristotle, and down to the date of the

> Twinkle, twinkle little star,
> I often wonder what you are,

of Dr. Watts, and the yet more modern conundrum of "Why are wicked old men like the fixed stars?" (the answer obviously being, "Because they sin 'till late") we have it recorded that the scintillation of the stars has excited the notice and admiration of mankind in all parts of the known world. But familiar as this phenomenon must have been to every one who ever gazed upon the night sky, it was reserved for Arago to give the first scientific explanation of its cause. Aristotle regarded it as an effect of the straining of the eye. Kepler thought it was caused by "moving vapours." Descartes, Hooke, Huyghens, and Newton were scarcely more fortunate in their guesses; while even Young, that great physicist of the early part of the present century, to whom we are mainly indebted for the establishment of the undulatory theory of light, regarded scintillation as inexplicable. Arago, however, as we have previously intimated, did furnish a solution of the difficulty, and his interpretation of the phenomenon amounted to this: that rays of light coming from a point, like a fixed star, and traversing an atmosphere composed of strata of various temperatures, densities, and humidity, must travel with different velocities. If now we collect these rays into a focus either by the lenses of the eye or those of a telescope, the result of the rays reaching us in different phases will be apparent in the alternate brightening and darkening of the image. This can, though, only happen where the rays issue from a *point*. If we consider a large disc like that of Jupiter, the rays would issue from such innumerable points that the effects would neutralise each other, and no twinkling would be apparent. This, too, explains why we only detect the faintest telescopic stars by their scintillation. Their phases of double light alternate with those of darkness, and it is during the former that they are momentarily seen to flash up in the field of view. Scintillation, then, is certainly primarily caused by luminous interferences, and Arago went on to explain the variation in colour of a twinkling star by the assumption that if the red rays were destroyed by interference, the resulting image would be white minus red, *i.e.*, green; while, if we assume that the green rays are similarly destroyed, the remaining light will be white minus green, *i.e.*, red; and so on.

This in effect represented the sum and substance of all that was known on the subject of scintillation up to about ten years ago, at which date M. Ch. Montigny, Professor at the Brussels Athenæum, commenced his exhaustive investigation of the whole subject—an investigation which has resulted in some curious and remarkable discoveries. In order that these may be properly appreciated, we propose in the outset to describe the elegant and ingenious apparatus devised by him for his researches, and which he calls a Scintillometer. We are indebted to M. Montigny himself for the details of this which follow.

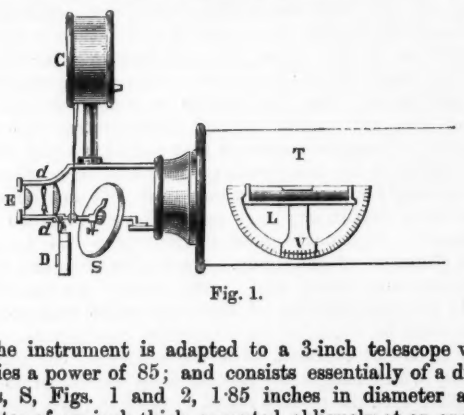


Fig. 1.

The instrument is adapted to a 3-inch telescope which carries a power of 85; and consists essentially of a disc of glass, S, Figs. 1 and 2, 1·85 inches in diameter and a quarter of an inch thick, mounted obliquely at an angle of about 17° on an axis A, close to, and in front of, the eye-piece of the telescope. In this position, the disc must always be traversed by the sheaf of rays converging from the object-glass, as it rotates round its axis, A, Fig. 2, which is parallel to and only 0·87 inch from the optical axis of the telescope. A hole perforated in the middle of the disc carries a brass ring, through which the axis of rotation passes. At that part of the axis immediately within this ring are fixed two pivots, *a*, Fig. 2, perpendicularly to it, whose ends enter two small openings pierced in the brass ring. The inclination of the disc to the axis of rotation is regulated by the brass spring, *s p*, Fig. 2, and the screw, *s c*, which latter passes through an arm tapped to receive it. A glance at our figure will show that while the spring tends to thrust the disc in a direction parallel with that of the axis A, the screw has a tendency to press it into a position at right angles to such axis; so that by the aid of these opposing pressures the disc may be fixed at any given angle of inclination. As we have said above, an inclination of about 17° is that adopted in practice. The disc is rotated by clockwork shown at C, Fig. 1, fixed on a short pedestal on the eye-tube of the telescope. This tube is shown in sec-

tion in our first figure, to exhibit the details of the fitting. The rate of motion of the clock is governed by a species of conical pendulum, or brake. An endless elastic band passes round the driving drum of the clock, and the pulley P, Fig. 2, on the axis of the disc, thus causing the disc to rotate with absolute regularity. What clock-makers call a lantern-pinion, *l p*, Fig. 2, placed in contact with the pulley, transmits the movement to a system of toothed wheels, by which the number of revolutions in a second are registered on the dial-plate D, Fig. 1. M. Montigny himself causes the disc to rotate five times in a second when scintillation is violent, and two and a-half times per second when but little twinkling is perceptible.

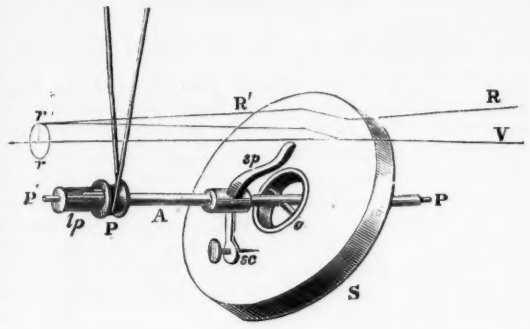


Fig. 2.

Every one knows that a luminous impression is retained for about the tenth of a second by the eye, so that a lighted stick whirled rapidly round produces the effect of a fiery circle. Upon a cognate principle a ray R, Fig. 2, emerging from the second face of the disc parallel to its original direction, will, as the disc rotates, seem to describe a circle *r r'* in the field of the telescope; so that when the telescope is turned towards a star, and the apparatus set in motion, the image of the star will be converted into a ring of light. If the star experiences no change, this ring will be homogeneous, and of an even tint; such tint being the colour of the star. But if the star twinkles, then will the circumference of this circle be divided into arcs of brilliant colours, which are continually changing. To count these arcs with the greatest exactness, M. Montigny employs a specially-devised micrometer, fixed behind the diaphragm *d d*, Fig. 1, in the focus of the eye-glass. This is shown in Figs. 3 and 4. It consists

Fig. 3.

Fig. 4.

of three fine wires crossing diametrically, so as to exhibit four equal sections in the telescopic field, each of such sections being equivalent to $\frac{1}{16}$th of the whole circular space. This micrometer is lighted in the usual way. Its centre may be placed in coincidence either with the centre of the circle described by the star's image, as in Fig. 3, or with a point in its circumference, as in Fig. 4. In the first case the number of colours appearing between two given lines at any instant obviously represent the number of colours into which $\frac{1}{16}$th of the circle is broken up; that circle presenting similar colours through its entire extent. In Fig. 4 *half* the number of colours comprised between two lines gives the number of changes comprised in $\frac{1}{16}$th of the entire circumference. Combining the number of colours displayed through the whole ring with the rate of revolution of the disc of glass, we can calculate the number of colour-changes that the image of a twinkling star experiences in a second of time. Now, the numerical result thus obtained evidently indicates the *intensity* of the scintillation of a star at any given height—a height at once shown by the divided circle with its vernier V and its spirit level L, which is shown attached to the telescope T, in Fig. 1. It is thus that M. Montigny's tables are to be interpreted. So much for his elegant apparatus. Let us see briefly the principal results that he has achieved by its aid.

The intensity of a star's twinkling may vary from three causes. First, its height above the horizon; secondly, the nature of its own intrinsic light; or, thirdly, the state of the atmosphere. Other things being equal, a star twinkles less the nearer it is to the zenith, the law of such diminution being expressible thus:—Save when close to the horizon, scintillation is proportional to the thickness of the stratum of air through which the star's light passes, multiplied by the astronomical refraction at the height at which we are regarding it. This, as may be seen, enables us to convert absolute intensity measured at any given height into relative intensity; such, for example, as it would exhibit when 30° from the horizon or had 60° zenith distance, the altitude to which M. Montigny refers all his observations. This reduction is easily made by means of a table. The star's intrinsic light has considerable influence on the intensity of its scintillation, so that the spectrum of a star* will enable us to say beforehand whether it will twinkle violently or not. M. Montigny expresses this in the form of the following law: "Stars whose spectra are characterised by dark bands and black lines scintillate less than those exhibiting fine and numerous spectral lines, and much less than those which only present a few principal lines. Castor, Vega, and Sirius are examples of stars which belong to this last-named group; Secchi's first type. As a result of an enormous number of observations, the mean scintillation (found as above) of all the chief stars exhibiting this kind of spectrum is 87. Secchi's second type of stars, whose spectra show very fine lines, α Cassiopeiæ, Polaris, α Ursæ Majoris, &c., only give a mean scintillation of 79; while Secchi's third type of red and orange stars, with nebulously banded and black-streaked spectra, such as Aldebaran, α Herculis, and α Orionis, exhibit a mean scintillation of 59. M. Montigny has also observed that in calm, settled weather the trace of the star in the scintillomter is sharp, even, and regular. Under the influence of rain it becomes less sharp, thicker, and diffused. During great atmospheric disturbance, squalls of wind, and the like, the ring of light becomes fringed, broken, or beaded. The stars twinkle most in January and February, and are most quiescent in June and July. The approach of rain and gales is heralded by an alteration in the scintillation; and it is much affected by the aurora. Hence it will be seen that the scintillometer furnishes us with a means of predicting coming atmospheric changes with very considerable accuracy. One of the most remarkable results, however, at which M. Montigny has recently arrived is, that magnetic storms and violent scintillation are absolutely coincident in point of time, a result which seems to open out a new field of investigation.

Thus have we endeavoured to give an elementary idea of the labours of the famous Belgian astronomer. It has seemed to us that those labours have been carried on in connection with a subject of which little or nothing is popularly known. May we hope that our description of

* The forthcoming papers on "Light Sifting (or Spectroscopic Analysis)," by the Editor, will thoroughly explain the meaning and signification of Star Spectra.

the simple and elegant apparatus of our Belgian *confrère* may stimulate English amateur astronomers in search of special work to provide themselves with it, and pursue the novel and interesting investigation which it was designed to facilitate?

PLEASANT HOURS WITH THE MICROSCOPE.

By Henry J. Slack, F.G.S., F.R.M.S.

MOST workers with the microscope attach themselves to a particular class of objects, but no special subject can be properly understood unless general knowledge has been acquired. Some readers may not intend to study botany, but that is no reason why they should not acquaint themselves with some of the most interesting facts concerning the structure and habits of ordinary plants. At this season there are many things worth notice, and some hints may be given concerning a few. For example, while everybody accustomed to rural scenes knows the look of the catkins of the hazel, which are formed early in the autumn for service in the following year, and ripen near London in February or March, comparatively few have seen the female flowers which open at this season. They are tiny things, invisible a few yards off, but extremely pretty, with their bright crimson stigmas protruding like silk threads out of what looks like a leaf-bud, but really belongs to the inflorescence, and contains the parts that are to form the future nuts. A low power shows them well, but the hairs of their scales are best seen with about 100 linear magnification, or more. They are tapering and hollow, and, when separated, look much like some of the simpler worms.

In warm situations the male flowers, or catkins, have lost most of their pollen, but some can still be shaken out on a glass slide. The pollen grains are so small that hundreds of them may lie on the slide without making it look dusty, or being visible, unless held up to the light. When the catkin is in perfection a shake with the wind,

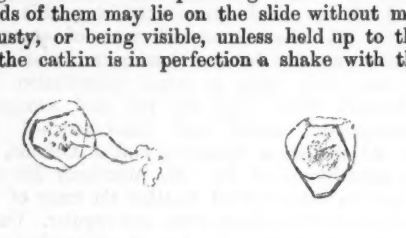


Fig. 1.—Hazel Pollen. $\frac{1}{6}$th × 320.

or with the hand, scatters the little vesicles like smoke. The figures above show some of them magnified 300 linear. The roundest are in the most perfect shape. They cannot be seen well except in some fluid, and easily alter their form. A waterdrop will do for a quick look, and dilute sulphuric acid is pretty sure to make some put forth pollen tubes from one or more of the transparent lid-like patches.

Quite another order of plants should be noticed at this season by the microscopist, namely, the allies of the fir-trees, or conifers. *Thujas*, *Cypresses*, and *Retinosporas* may be specially mentioned. They are *gymnosperms* or plants with naked ovules, and these ovules are very pretty things. Fig. 2 shows a female flower of *Thuja aurea*, a common and beautiful evergreen shrub, very broad in proportion to its height. The little bottles represented in the sketch are the ovules with open mouths. The male plants are produced at the end of other branchlets. The female flowers are now in great abundance, and their yellow, waxy colour throws a golden glow over the plant, contrasting finely with the light green of the leaves. The female flowers vary in the number of ovules; most of those I have looked at bore six, but some eight. The distinction between *gymnosperms* and the angiosperms, which contain most of the common plants, is that the former expose their ovules directly to the pollen, while the latter are provided with a pistil which catches the pollen and allows itself to be traversed by tubes which the pollen grains emit and send down to the ovary.

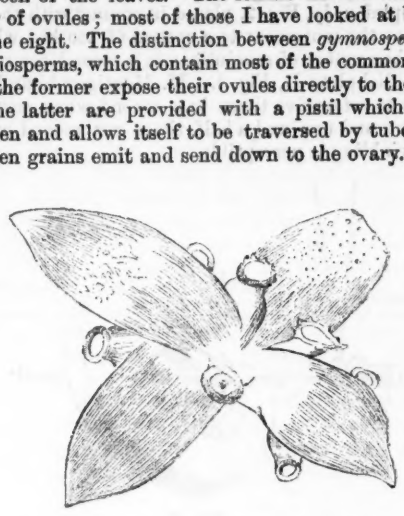


Fig. 2.—Female Flower of Thuja Aurea.

The male flowers of some gymnosperms are particularly ornamental. Those, for example, of the *Cupressus Lawsoniana* (Lawson's Cypress) form, when ripe, a beautiful red coral-looking fringe to the branchlets. Mine are now black; but in warmer places than Ashdown Forest they have probably turned red, as mine will be in a few weeks. The *Retinosporas* are much decorated with these flowers. *R. leptoclodium* is now full of terminal flowers, contrasting with its green leaves. All the conifers and their allies will supply something interesting for the possessor of a microscope to watch for many weeks to come. The enormous quantity of pollen produced by the fir tribe is very striking. Plants depending upon wind fertilization always form vastly more than can be used in the work of impregnation, but we are not entitled to suppose it lost. A continuous change of matter from the inorganic to the organic condition, and back again in a similar circuit, seems necessary to the order of nature.

Among quite other plants interesting to the microscopist are the *Deutzias scabra* and *gracilis*, both common in good gardens south of London. The latter as a greenhouse plant has seen its best days, but in the open border it has only formed young leaves and early buds. The youngest leaves may be soaked for a few days in strong methylated spirit, to dissolve out the chlorophyll, and then, after cutting out the midrib, mounted in Canada balsam. Prepared this way, it has some advantage over the cuticle of *D. scabra*. It should be viewed with polarised light, and selenite or mica, so arranged as to show the starlike hairs on a dark chocolate ground. It is not a good object on most of the light grounds. The very young buds of *D. scabra* are worth looking at. The "Treasury of Botany" especially alludes to *D. Staminea* as sought for on account of stellate hairs, but I have not got it and do not know it.

Darwin's Berberry is in flower, and its anthers should be examined. When the pollen is ripe, two flaps, or trap-doors, open, and stand out from the filament like two arms held away from the body. Early rhododendrons are, or

will be soon, in blossom, and their anthers are elongated bags, with two round openings at the top.

Bay-trees are coming into flower, and their anthers have two lids, and the filaments have wing-like projections.

The oval pollen of the blue squill, *Scilla siberica*, and the spiral fibres attached to the filament, are also good objects.

These are a few of the things to be noticed, but the list might be extended to any length. Young people, Sir John Lubbock says, are fond of natural history, until the taste is educated out of them. Certainly, too much "poring over miserable books," and neglect of using the eye and its optical assistants, leads to stupidity, though it may help to pass Cambridge examinations.

INTELLIGENCE IN A POINTER.

DON was a pointer dog of large experience that I shot with over forty years ago. At that time the pinnated grouse were abundant in our wild prairies. The birds were more frequently found in particular localities in different parts of the day. They affected the low grounds or swales, where the grass was long, in the heat of the day, and in the morning and evening they resorted to the high, rolling prairie. In a cool, cloudy day they were likely to remain on the high grounds. Don had learned this as well as his master, and when taken into the field it was interesting to observe the dog, when on the prairie, deliberately surveying the ground and then start out and range over the same ground his master would have selected.

This was the result of education and observation, and was not peculiar to Don. I have known many old bird dogs do the same. But there was one thing which Don had not been taught in training, but which he had adopted of his own motion, as the result of his own reasoning or reflective powers.

When a young bird gets separated from its companions, or it may be is the last of a covey which has escaped the fowling-piece, it is apt to wander a good deal, and the dog may follow its trail for a considerable distance. When pressed it will seek short cover if convenient, and there the trail is frequently lost. In such cases I have frequently seen Don hunt about rapidly and irregularly for a short time, and if still unsuccessful he would return to the last point where he could detect the scent, and then commence to hunt in a circle, enlarging the circle by perhaps two feet in the radius, and these were made with wonderful regularity till he had covered the ground for many rods around, if the want of success required it, but he generally found the bird within ten or twelve feet of the starting-point. I once knew him to go over the ground a second time in the same way before he was successful.

Invariably the bird was found to have concealed itself in a deep narrow depression in the prairie.

I repeat that the dog had not been taught, but had adopted it voluntarily, or, it was his own invention.

I never knew any other dog to do this, although a book could be filled with accounts of smart things which bird dogs have been known to do.—J. D. CATON, in *The American Naturalist*.

NOTES ON MAPPING.

BY RICHARD A. PROCTOR.

IT is hardly necessary to remark, perhaps, that what I have said respecting star-maps is true of geographical maps also. The conical projection described in my former paper is undoubtedly the most satisfactory for presenting regions of the earth of moderate extent; and is far preferable to the constructions employed in our atlases even for showing continents. It is difficult to understand how these preposterous constructions came first to be employed, or why, having once been employed, they have not long since disappeared, making way for one or other of several constructions which are far better suited for the purpose in view.

Let us take for instance the continent of Africa, though this is not by any means the worst case. Africa is always presented on the projection known as Flamsteed's, as also is South America; while Europe, Asia, and North America are presented on a singular mixture of Flamsteed's projection and the conical projection, reflecting more credit on the inventor's ingenuity than on his common sense, since it combines the defects of both systems, and has none of the good qualities of either.

Taking Africa for the application of Flamsteed's system, we proceed as follows:—We first draw a series of equidistant parallels to represent the parallels of latitude ten degrees (say) apart, and a line crossing them at right angles to represent the central meridian of our map. Then from the points in which this line crosses the parallels we measure off along each parallel a series of distances each corresponding to ten degrees of longitude on the parallel we are dealing with. Thus along the equator these distances are equal to that between the parallels first drawn; in latitude 40 north or south they are only equal to 766 thousandths of that distance; and so on for each latitude parallel. Then we join the points thus obtained by a series of curved lines forming the meridians on either side of the central straight one. It is unnecessary to give an illustrative figure, for the simple reason that every atlas map of Africa will serve. If the reader examines the corner spaces in such a map and compares them with the mid-spaces between the same parallels, which are nearly of the right shape, he will see how great the distortion is. Then the distortion is widely variable in different parts of the map—always a serious defect. The scale not only varies in different parts of the map, moreover, but it is widely variable in different directions. A scale of miles is complacently given, which is untrue for large parts of the map—except in measuring directions parallel to the equator.

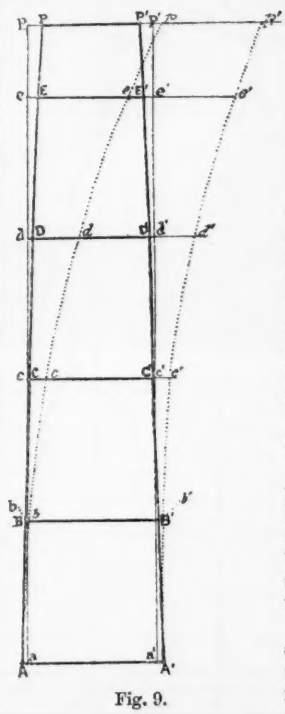


Fig. 9.

The actual distortion near a corner of one of the Atlas maps of Africa is illustrated in Fig. 9. Here P E D C B A and P′ E′ D′ C′ B′ A′ are two meridians, crossed by the equator at A A′, and successive parallels of latitude, 10° apart, in B B′, C C′, D D′, and E E′: *p e d c b* and *p′ e′ d′ c′ b′* are two such meridians near the left side (north of equator) of a map of Africa.

In the same Fig. 9 is shown the shape of the same portion of the map, if the conical construction, which at the

equator becomes cylindrical, is adopted. The meridians here assume the position p e d c b a and p'e'd'c'b'a', whose distance apart is made nearly equal to that corresponding to the mean between the length of ten degrees for the equator and for latitude 35° north. (This is rather better from objection. The areas increase on either side of the equator as shown in Fig. 9; but not much within the limits of Africa itself. Preposterous changes of shape are avoided, though equatorial regions are slightly compressed and regions north of 15° slightly expanded in latitude.

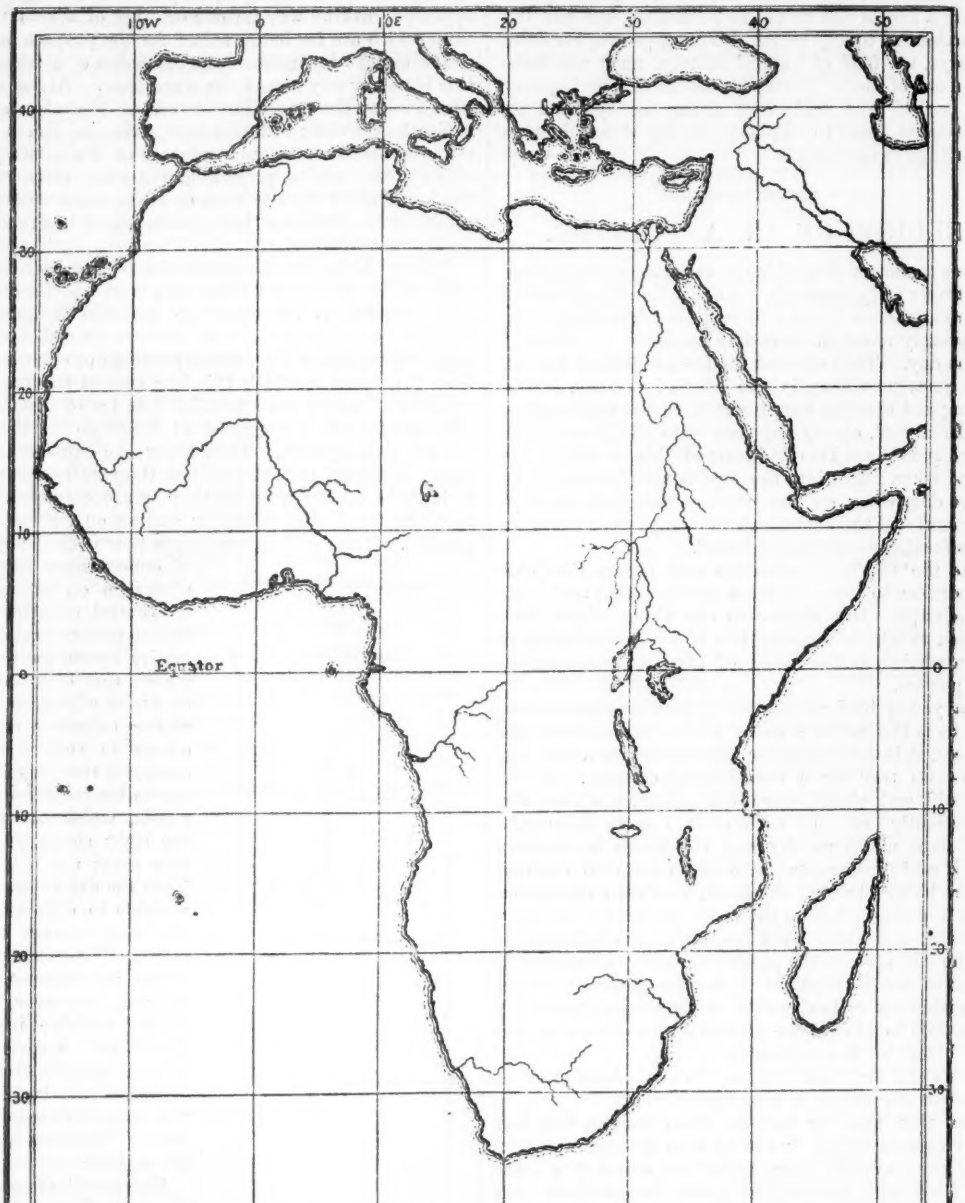


Fig. 10.

than taking the mean between 0° and 40°, because the greater part of the outline of Africa falls between the parallels 35° north and south of the equator.)

The cylindrical projection is far superior to Flamsteed's for a map of Africa, though by no means absolutely free

I have drawn a little map of Africa (Fig. 10) on the cylindrical projection, so that the student may compare the shape of the continent as thus mapped with the shape given in atlas maps. Perhaps the best evidence of the superiority of the cylindrical projection, (which is also far simpler in

construction) will be found on comparing the figures of Spain, Arabia, and the Caspian Sea with the real shapes on the one hand, and with the distorted figures of these regions in the atlas maps of Africa.

I propose to take an early opportunity of giving a map of Africa on the stereographic projection, and then one on the equidistant construction, both of which are far better for so large a region than even the cylindrical,—though this, as can be seen by Fig. 10 is far superior to Flamsteed's.

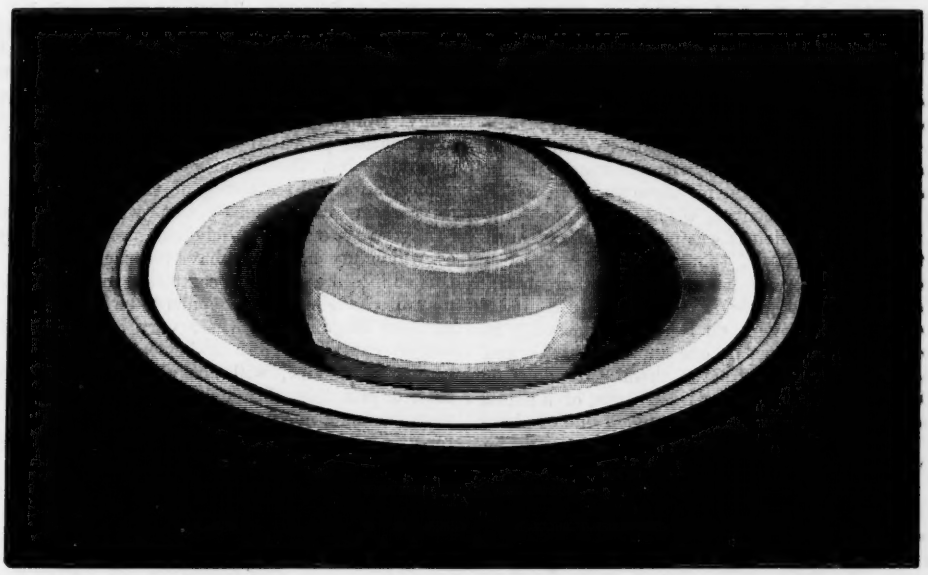
(To be continued.)

A FEW SATURNINE OBSERVATIONS.*

HERE is a gentleman at our doors, Mr. R. A. Proctor, who has written a book upon that planet Saturn, and he asks us to stroll out in his company, and have a look at the old gentleman. It is a long journey to Saturn, for his little place is nine and a-half times further from the sun than ours, and his is not a little place in comparison with our own tenement, because Saturn House is seven hundred and thirty-five times bigger than Earth Lodge.

The people of Earth Lodge made Saturn's acquaintance very long ago; nobody remembers how long. Venus and Jupiter being brilliant in company, may have obtruded themselves first upon attention in the evening parties of the stars, and Mars, with his red face and his quick movement, couldn't remain long unobserved. Saturn, dull, slow, yellow-faced, might crawl over the floor of heaven like a gouty and bilious nabob, and be overlooked for a very little while, but somebody would soon ask, "Who is that sad-faced fellow with the leaden complexion, who sometimes seems to be standing still or going backwards?"

He was the more noticeable, because those evening parties in the sky differ from like parties on earth in one very remarkable respect as to the behaviour of the company. We hear talk of dancing stars, and the music of the spheres, but, in fact, except a few, all keep their places, with groups as unchanging as those of the guests in the old fabled banquet, whom the sight of the head of Medusa turned to stone. Only they wink, as the stone guests probably could not. In and out among this company of fixtures move but a few privileged stars, as our sister the moon and our neighbours the planets. These alone thread the maze of the company of statues, dancing round their sun, who happens to be one of the fixed company, to the old tune of Sun in the middle and can't get out. Some of the planets run close, and some run in a wide round, some dance round briskly, and some slip slowly along. Once round is a year, and Saturn, dancing in a wide round outside ours, so that in each round he has about nine times as far to go, moves at a pace about



three times slower than ours. His year, therefore, is some twenty-seven times longer; in fact, a year in the House of Saturn is as much as twenty-nine years five months and sixteen days in our part of the world. What, therefore, we should consider to be an old man of eighty-eight, would pass with Saturn for a three-year-old.

A hundred and fifty years ago, Bishop Wilkins did not see why some of his posterity should not find out a conveyance to the moon, and if there be inhabitants, have commerce with them. The first twenty miles, he said, is all the difficulty; and why, he asked, writing before balloons had been discovered, may we not get over that? No doubt there are difficulties. The journey, if made at the rate of a thousand miles a day, would take half a year; and there would be much trouble from the want of inns upon the road. Nevertheless, heaviness being a condition of closeness and gravitation to the earth, if one rose but the first twenty miles, that difficulty of our weight would soon begin to vanish, and a man—clear of the influence of gravitation—might presently stand as firmly in the open air as he now does upon the ground. If stand, why not go? With our weight gone from us, walking will be light exercise, cause little fatigue and need little nourish-

* I have often been asked whether this paper, which appeared in *All the Year Round*, on Sept. 2, 1865, was written by Charles Dickens. I have no means of knowing; though it is tolerably easy to form an opinion from internal evidence. Now that Saturn is departing from our skies I have thought readers of KNOWLEDGE might be interested to read this quaint paper, the first notice of importance which my first book received from the public press. It is illustrated by a view of Saturn taken from that work of mine, showing the planet as seen on March 23, 1856, and as he appears at present and will appear again next year.—R. A. PROCTOR.

ment. As to nourishment, perhaps none may be needed, as none is needed by those creatures who, in a long sleep, withdraw themselves from the heavy wear and tear of life. "To this purpose," says Bishop Wilkins, "Mendoza reckons up divers strange relations. As that of Epimenides, who is storied to have slept seventy-five years. And another of a rustic in Germany, who, being accidentally covered with a hayrick, slept there for all autumn and the winter following, without any nourishment." Though, to be sure, the condition of a man free of all weight is imperfectly suggested by the man who had a hayrick laid atop of him. But what then? Why may not smells nourish us as we walk moonward upon space, after escape from all the friction and the sense of burden gravitation brings? Plutarch and Pliny, and divers other ancients, tell us of a nation in India that lived only upon pleasing odours; and Democritus was able for divers days together to feed himself with the mere smell of hot bread. Or, if our stomachs must be filled, may there not be truth in the old Platonic principle, that there is in some part of the world a place where men might be plentifully nourished by the air they breathe, which cannot be so likely to be true of any other place as of the ethereal air above this? We have heard of some creatures, and of the serpent, that they feed only upon one element, namely, earth. Albertus Magnus speaks of a man who lived seven weeks together upon the mere drinking of water. Rondoletius affirms that his wife did keep a fish in a glass of water without any food for three years, in which space it was constantly augmented, till at first it could not come out of the place at which it was put in, and at length was too big for the glass itself, though that were of large capacity. So may it be with man in the ethereal air. Onions will shoot out and grow as they hang in common air. Birds of paradise, having no legs, live constantly in and upon air, laying their eggs on one another's backs, and sitting on each other while they hatch them. Rondoletius tells, from the history of Hermolaus Barbarus, of a priest who lived forty years upon mere air. And, if one of these possibilities be admitted, why, we can take our provision with us. Once up the twenty miles, we could carry any quantity of it the rest of the way, for a ship-load would be lighter than a feather. Sleep, probably, with nothing to fatigue us, we should no longer require; but if we did, we cannot desire a softer bed than the air, where we may repose ourselves firmly and safely as in our chambers.

As for that difficulty of the first twenty miles, it is not impossible to make a flying chariot and give it motion through the air. If possible, it can be made large enough to carry men and stores, for size is nothing if the motive faculty be answerable thereto—the great ship swims as well as the small cork, and an eagle flies in the air as well as a little gnat. Indeed, we might have regular Great Eastern packets plying between London and No Gravitation Point,* to which they might take up houses, cattle, and all stores found necessary to the gradual construction of a town upon the borders of the over-ether route to any of the planets. Stations could be established, if necessary, along the routes to the Moon, Mars, Venus, Saturn, and the rest of the new places of resort; some London Society could create and endow a new Bishop of Jupiter; and daring travellers would bring us home their journals of a Day in Saturn, or Ten Weeks in Mars, while sportsmen might make parties for the hippogriff shooting in Mercury, or bag chimeras on the Mountains of the Moon.

(To be continued.)

* But alas, this point would be not 20, but 150,000 miles away.—R. P.

THE UNIVERSE OF SUNS.

By Richard A. Proctor.

(Continued from page 146.)

It was not however until 1811—nine years later be it noticed, and more than a quarter of a century after the examination of the theory of 1785, that Herschel first propounded a definite theory concerning the milky nebulosity. I have elsewhere had occasion to refer to his analysis of the various orders of nebulæ, in the masterly essay of 1811, and shall here therefore merely give a summary of his ideas. But before doing so it is essential to quote the words with which Herschel opens this memoir, because they will serve to remove any lingering doubts which the reader may still entertain respecting the truth of my assertion that Herschel's ideas underwent a marked change during the later part of his career as an observer.

"I must freely confess," says Herschel, speaking of the disagreement between his new views and those he had formerly entertained, "that by continuing my sweeps of the heavens my opinion of the arrangement of the stars and their magnitudes, and of some other particulars has undergone a gradual change; and indeed when the novelty of the subject is considered, we cannot be surprised that many things formerly taken for granted, should on examination prove to be different from what they were generally but incautiously supposed to be. For instance, an equal scattering of the stars may be admitted in certain calculations; but when we examine the Milky Way, or the closely compressed clusters of stars, of which my catalogues have recorded so many instances, this supposed equality of scattering must be given up. We may also have surmised nebulæ to be no other than clusters of stars disguised by their very great distance; but a longer experience and a better acquaintance with the nature of nebulæ, will not allow a general admission of such a principle, although undoubtedly a cluster of stars may assume a nebulous appearance when it is too remote for us to discern the stars of which it is composed."*

Herschel then proceeds to exhibit his ideas respecting the gradual evolution of stars from truly nebulous matter. He shows that diffused nebulosity exists in great abundance over the heavens, insomuch that notwithstanding the extreme difficulty of detecting it he recognised its presence over more than 150 square degrees of the heavens, "its abundance," as he said, "exceeding all imagination." He shows that this diffused nebulosity is often associated with real nebulæ, citing as a particular instance the great nebula in Orion; and that often detached nebulosities of this kind can be recognised. He points out that such detached nebulosities when small must be classed as nebulæ. Then he mentions instances in which nebulæ of this sort—that is, milky nebulæ—show signs of condensation, either in one place or in several. Regarding these signs as indicating the formation of one or more nebulæ from a region of diffused nebulosity, Sir W. Herschel is careful to show that the idea derives support from the remarkable association of many nebulæ which are thickly spread in cer-

* It will be observed that in this passage Herschel abandons two of the views he had formerly entertained,—the general uniformity of stellar distribution, and the theory that all the nebulæ are systems of stars. Presently I shall have occasion to show that yet a third essential point in the views of 1785 was abandoned by Herschel quite as definitely; but I would invite special attention to the circumstance that *each* of the two views here given up, was of itself essential to the theory of 1785. Two links of the chain of ideas then enumerated were in effect rejected by Herschel, in 1811, as broken (under the strain of observations); so that the chain itself was broken.

tain regions of the heavens, while other regions are as remarkably free from nebulæ. He next considers the form of the discrete nebulæ, describing some which appear to be extended only in one direction, others that have length and breadth but no great thickness, others that are irregular, and others which have an irregular round figure. He infers that these various figures indicate the successive figures which one and the same nebula assumes during the process of condensation, the further effects of this process being illustrated, in order;—by round nebulæ; by nebulæ that are gradually a little brighter in the middle; brighter in the middle; much brighter in the middle; and suddenly much brighter in the middle; by nebulæ increasing gradually in brightness up to a nucleus; by nebulæ that have a well-marked nucleus; by planetary nebulæ which are uniformly bright but whose light "must be considerably more condensed than that of the foregoing sets*"; and lastly by nebulous stars more or less clearly recognisable as such, those only barely to be distinguished from stars being but one stage from the final stellar condition to which the whole series has tended.

Such briefly stated is the famous theory of the formation of stars from nebulous matter. It will be observed that Herschel here extends (and also illustrates from the heavens themselves), the ideas he had first enunciated in 1789. He pictures every stage of the progress of such matter from its most diffused state up to the last state in which the condensing nebula can be distinguished from the star itself; and he remarks that there is perhaps not so much difference between these different states, as there would be in the condition of the human frame from one year to another, were it described "from the birth of a child till he comes to be a man in his prime." "The end I have had in view," he says, "has been to show that the above-mentioned extremes may be connected by such nearly allied intermediate steps as will make it highly probable that every succeeding state of the nebulous matter is the result of the action of gravitation upon it while in a foregoing one, and by such steps the successive condensation of it has been brought up to the planetary condition. From this the transit to the stellar form, it has been shown, requires but a very small additional compression of the nebulous matter, and several instances have been given which connect the planetary to the stellar appearance. The faint stellar nebulæ have also been well connected with all sorts of faint nebulæ of a larger size; and in a number of the smaller sort, their approach to the starry appearance is so advanced, that in my observations of many of them it became doubtful whether they were not stars already."

In the memoir of 1811 Herschel does not discuss the condition of star-clusters of any orders. In fact, as he points out, the paper does not deal at all with the sidereal part of the construction of the heavens. We must pass on to the paper of 1814 to ascertain the direction in which Herschel's ideas on this part of his subject had been tending since he had first seen reason to question the ideas of 1785. It will be well to quote Herschel's own account of his purpose in the memoir of 1814, since in this case as in many others his meaning has been misapprehended.†

"The observations contained in this paper," he says, "are intended to display the sidereal part of the heavens, and also to show the intimate connection between the two opposite extremes, one of which is the immensity of the widely diffused and seemingly chaotic nebulous matter; and the other the highly-complicated and most artificially constructed globular clusters of compressed stars. The proof of an intimate connection between these extremes will greatly support the probability of the conversion of one into the other." It will be observed that Herschel here definitely describes as the extremes of observable creation, the self-luminous nebulous matter on the one hand and the compressed globular clusters on the other.

He then proceeds to show how stars are sometimes "remarkably situated with regard to milky nebulosity," citing specially double stars connected by nebulous matter, stars with nebulous appendages, and those nebulous stars which closed the series considered in the Memoir of 1811. Furthermore there are stars connected with extensive windings of nebulosity, as well as "small patches consisting of stars mixed with nebulosity." "Admitting from what has been said," he remarks, "that stars may be formed of nebulous matter, it may happen that the nebulosity still mixed with them is some remaining unsubsided part of that from which they were formed;" *or* "a union of stars and nebulosity, originally at a distance from each other, may have been effected by the motion of either the stars or the nebulosity." "Every nebulosity which is carried into the region of a small patch of stars will probably be gradually arrested and absorbed by them, and thus the *growth of stars* may be continued." This part of the paper, forming a connecting link, as it were, between the subjects of the Memoirs of 1811 and 1814, concludes with the consideration of objects of an ambiguous construction,—that is, "of such a construction or at such a distance from us that the highest power of penetration which hitherto has been applied to them, leaves it undetermined whether they belong to the class of nebulæ or stars."

For much of what relates to the sidereal heavens, Herschel refers to the paper of 1785, and it may be that this reference has presented most of his commentators from noticing that his ideas as to the distribution of the stars, differ markedly in 1814 from those he had adopted in 1785. He refers back to the earlier paper only with regard to individual suns. So soon as he deals with the aggregation of the stars, we find that though he still refers to the star gauges of 1785 he interprets them on principles altogether different from those he had formerly adopted. He dwells afresh on what he had written in 1802 respecting the clustering condition of portions of the stellar heavens. He explains that his expression "forming clusters," was used "to denote that some peculiar arrangement of stars in lines making different angles, directed to a certain aggregation of a few central stars, suggested the idea that they" (the former) "might be in a state of progressive approach to them" (the latter). "This tendency to clustering seems chiefly to be visible in places extremely rich in stars. In order, therefore, to investigate the existence of a clustering power, we may expect its effects to be most visible in and near the Milky Way." I would invite the reader's special attention to the circumstance that the Milky Way is here pointedly referred to as a stellar region distinct in its characteristics from the region of the stars forming our constellations. In studying Herschel's papers we have to be continually on the watch for indications of the sort; since he does not always judge it necessary to make definite assertions of his views on such points.

He then describes irregular clusterings of stars, noting

* This is the weakest part of Herschel's chain of reasoning. It is not easy to recognise the systematic nature of a process of change, which after converting round nebulæ of uniform lustre into nebulæ with a nucleus leads next to the small round planetary nebulæ of uniform lustre, and thence to nebulæ with a star for nucleus.

† Not from any real indistinctness in his mode of expression but (here as in other cases) because the attempt has been made to reconcile the views expressed at one time with views expressed much earlier, and when as yet the available evidence had not been even collected, far less examined.

in particular that "though they are in general very promiscuously scattered they are yet sufficiently drawn together to show that they form separate groups," while in many places a falling off in the number of stars surrounding the clusters indicates "a tendency to future insulation." "*Those which are in, and very near the Milky Way*," he says, "*may be looked upon as so many portions of the great mass drawn together by the action of a clustering power, of which they tend to prove the existence.*"* In describing the various orders of irregular clusters, Herschel is particular to notice *rows* and *streams*, *ridges* and *shelvings* of stars, as indications of a preponderating clustering power.

(*To be continued.*)

TRICYCLES IN 1884.

By John Browning,

Chairman of the London Tricycle Club.

TRICYCLE EXHIBITION AT THE AGRICULTURAL HALL.

THE Lecture at the Royal Institution on "Cycling" was happily timed, coming just at the beginning of the riding season, and during the Exhibition at the Agricultural Hall, which was the largest exhibition of tricycles yet seen. I trust that all my readers who are interested in tricycles will have taken the opportunity of inspecting this great collection of machines, as it was closed on Saturday last the 15th inst. There were many novelties at this show which were not exhibited at the Floral Hall in February, notably three new two-speed gearings—one exhibited by Leni, one by Rucker, and one by Rudge. They are all modifications of the "Sun" and "Planet" gearing, and all of them are good—so good that only a careful trial would enable any one to pronounce an opinion as to which was the best.

I only propose to enumerate here a few of the most novel or important exhibits; very shortly I hope to be able to give more lengthened descriptions of the machines of the greatest value.

First, a few words on bicycles, because any improvement in those machines will almost certainly be found to be applied very soon to tricycles. One exception to this rule I must name, on account of its simplicity, originality, and efficiency—Rucker's "Tandem Bicycle," which is undoubtedly the fastest machine yet contrived. It is a bicycle with two large wheels, only the two riders both steer. At first sight it appears a dangerous machine, but I am assured that it is really safer than an ordinary bicycle, because it is not possible for either rider to be thrown off from it over the handles.

The new "Safety" bicycle introduced by Robinson & Spence (?) is a bicycle in which, by dispensing with the cross-bar handles, it is believed that the liability to headers may be obviated. An open front is gained in a very ingenious manner by carrying the ends of the large hollow forks down under the riders' feet, and then bringing them up in the form of the letter U, the handles being on the outside of the U. The inventors have immediately applied this contrivance to the tricycle, giving us a "Humber," with an open front, though the machine is not so graceful in appearance as the original. The "Safety" bicycle is clumsy in appearance, and must be heavier by several pounds than machines of the usual construction, but its undoubted advantage on the score of safety may lead to its adoption.

Humber's new "Tandem" tricycle is also a light and very fast machine, probably faster than an ordinary bicycle. It is simply the well-known "Humber" tricycle, with a seat for a second rider in front of the handles. This rider drives by a chain a wheel placed on the axle. The machine can very easily be converted into the single form, leaving only the chain wheel, weighing but 1 lb. at the utmost, upon the axle. The machine requires more skilful management than an ordinary "Sociable," in which the two riders sit side by side, but I am told that it is easier to ride and steer than the single "Humber" tricycle. Very soon I shall have an opportunity of riding it, and then I will give an account of my experience as to its performance.

Keen's "Eclipse" tricycle is a central-geared front-steerer, well planned and very light. The double-driving gear is in the centre, and is open so that it can be oiled or cleaned at pleasure.

The "Grosvenor" is a machine introduced by Hart, Son, & Peard, of Regent-street, based on the "Coventry," having only one large driving-wheel and two steering-wheels, both on the same side. One small steering-wheel stands well out in front, and the other is just behind the rider. The steering arrangement is very neat and effective, being entirely contained within the side-bar, and the machine has an open front. The work is good, and the price reasonable. I should be glad to know more of this machine than I could gather at the Show.

I was greatly pleased to see, at last, some sensible tricycles for children. Scantlebury has the cheapest. His machines at fifty shillings have a double-tyre break; while some makers display machines at more than double the price with a break *on one wheel only*. Lloyd had some children's machines of superior make, highly finished, and nickelised, with good brakes, at the price of £5; while Singer's showed a reduced model of their excellent front steerer, the "Apollo," at ten guineas, which would serve for any lad or lass up to the age of fifteen or sixteen.

Before concluding, I would direct attention to Lucas's admirable "King of the Road" lamps, which are the most complete and perfect I have yet seen. They are of great illuminating power, easy to light, difficult to be blown out, and, though small, will burn without refilling for eight hours.

* The passage I have here emphasised deserves as careful study as the passage similarly emphasised in the paper of 1802. It is as obviously inconsistent with the theory of uniform distribution of stars throughout the galaxy.

"LET KNOWLEDGE GROW FROM MORE TO MORE."

(*In Memoriam.*)

Who shall compass Knowledge?
Who with straining ear shall blend
From minds of men, and wood, and wave,
The harmony her movements lend?

Time shall bring us Knowledge:
Time, whose fost'ring formed the earth,
Marked the shores her waters lave,
Gives the bud the rose's worth.

In the growth of ages
Knowledge shall reveal her might;
She shall read the universe
In her twin-born sister's light:

In the radiance wisdom sheds,
Knowledge comes, and Virtue spreads.

Helen Auxilium King.

Gossip.

WE are glad to see that Dr. Andrew Wilson is to give the four lectures of the course which he delivered last Christmas in Princes' Hall, Piccadilly, at the Guildhall, Plymouth. I have a lively recollection of the welcome extended to me last autumn in that splendid hall, and should be glad to hear that the Editor of *Health* had been as kindly greeted as the Editor of KNOWLEDGE. His subject should prove even more generally interesting. For while we necessarily take but an outside interest in sun, moon, and stars, we are all vitally interested in the structure and mechanism of our own bodies. In these days when every one is learning not only how to take care of his own personal body, but to look after his fellow-creatures' bodily welfare in a scientific way, we cannot but follow with interest the teachings of medical men,—our Richardsons, Carpenters, Wilsons, and so forth. With care and time will come the proper application of the facts which they bring to the knowledge of the lay community.

WE heard a few days since, by the way, of a rather odd development of surgical teaching. A class of ladies, students of the Ambulance Corps, had been carefully taught how, by means of a tied handkerchief, pad, and a ruler (to twist and so tighten the handkerchief), the bleeding of an artery in the arm or leg may be stopped. The remedy, unscientifically applied, is a little dangerous, and we recently heard of a case in which where no artery had been wounded, strong but unnecessary pressure had nearly caused mortification. Be this as it may, the extension of the method to the case next to be considered was certainly unexpected and perhaps mistaken:—"How would you proceed," the ladies were asked afterwards in examination, "in the case of a person bleeding from a bad wound in the head?" "I would tie a handkerchief round the neck," came the answer, "apply a pad to the throat, and with a ruler inserted under the knot at the back of the neck, I would tighten the handkerchief until the bleeding ceased." The remedy would be undoubtedly decisive.

RATHER than have such experiments tried one would almost prefer the spread of such happy ignorance among laymen as was indicated in the reply (really made) to the question, "Describe the circulation of the blood?"—"The blood goes down one leg and up the other."

SIR GEORGE AIRY, by the way, calls attention to the mistake of describing as "arterial drainage" a system which if named by reference to the circulation should be called "venous."

RETURNING to the subject of lectures, I may take this opportunity of expressing my sense of the kindly welcome extended to me in Gloucestershire and Somersetshire during the past few weeks. I shall never forget the splendid audiences in the Greater Colston Hall, at Bristol, or the pleasant warmth of their greeting. At Bath and Cheltenham, again, my whole course of six lectures was attended by crowded and kindly audiences. And at Taunton, one of the brightest and pleasantest places in England, I was similarly welcomed, though naturally, with a much smaller population, the audiences were smaller also. At Gloucester, only, were the audiences below par,—Gloucester in fact gave an audience smaller in proportion than any place except Reading which I have yet visited. Probably the progress of the Gilchrist lectures, with penny admissions, may have exerted a demoralising influence. Certain is it that the manager of the course was asked for half-price on school admissions already reduced to sixpence. But the local press made up for this, I am told, by asking (so at least did the generous *Citizen*) for fifty per cent. above their customary advertising rates. This gave an air of dignity to the proceedings at Gloucester which may be better imagined than described.

WESTON'S walk shows that in the open air a man can continue steady work, not very heavy while it lasts, for ten or twelve hours per day, six days out of seven, in the open air, for seventeen weeks, without taking any alcoholic stimulant. Among our working classes are many who continue steady work, harder while it lasts, for more than twelve hours per day, with less complete rest on Sundays, in badly-ventilated places, for years together, some of them without any alcoholic drinks, and others, again, without suffering appreciably (so far as appears) from a glass of beer, or of spirits and water, daily. Now, if some one would try the following experiment, the real danger of even the moderate use of stimulants would, I fancy, be more clearly made apparent. Let two men of equal strength, and in equally good condition, be for twelve weeks without exercise or with insufficient exercise, and let one of them during that time take daily such an allowance of alcoholic stimulant as men living actively and much in the open air can take without harm; let the other takes none: then let the conditions of these men be tested by medical experts and compared with their condition before the twelve weeks began. I fancy the former will be found to have suffered much more than the latter, though both will no doubt have lost condition.

PEOPLE who know nothing about the phenomena of so-called mesmerism are apt to be as unwise in their incredulity as some who have witnessed the performances of mesmeric charlatans have been in their gullibility. Mr. Langley has done good service in showing at the Royal Institution that certain mesmeric influences are demonstrable, for he mesmerised the unhappy frog (always invited to these entertainments), and, by way of change, a lively alligator. He was probably not far from the truth in saying that human beings cannot be mesmerised against their will, though of course multitudes of instances seem to prove the reverse.

I HAD no idea that the writer who had told Mr. Sala to be silent about matters English because he was not of English blood would ever see the pages of KNOWLEDGE, and still less had I any particle of personal feeling against him. Mr. Sala only gave us one sentence from a series which he described as a perfect string of pearls, and that sentence was so ludicrously pompous and stilted that it seemed natural to imagine the writer to correspond. But I really am sincerely sorry that regarding him in this absolutely impersonal way, I spoke of him as a solemn idiot; for he turns up *in propriâ personâ*, and as a man of science (he says), with a very natural wish to castigate me in bodily conflict, where his "complete victory over" me "would be hallowed by the cheers of assembled thousands gathered to view the tourney, while" he, "doffing his casque to the acclamations of the people would have presented on" his "lance's point" my "bleeding and lacerated head, as a fitting offering to the lady of" his "choice. But alas, we are fallen on degenerate days!" Without doubting that the lady of *his* choice would find a bleeding and lacerated head a cheerful gift, and be able to make pleasing use of

the same, I may remark that I should have declined the contest on the plea that I had no right to call my admirer a "solemn idiot" without better knowledge of him. If, after that admission, and regretful apology, he insisted on the fight, then truly should I have taken heart of grace, and have done my endeavour to keep my head unlacerated and therefore unbleeding, as being in that state more pleasing to the lady of *my* choice. My correspondent, adopting the title of "A Solemn Idiot," which really seems unsuitable for one of such positive character (idiocy being purely negative), recommends that to correct the large proportion of non-English blood in their veins (if royal persons *have* veins) our royal families should immediately begin to "intermarry with families of English blood and noble birth, whose ancestors have fought for their country, and whose modern representatives belong to the right side in politics, that is to say, the Fourth Party." If "his will were paramount," he would perhaps bring this about, but, then, it is not: there is much virtue in your "if."

I rejoice to see from a pamphlet sent me by Mr. Irving that the Lyceum Company has won esteem throughout America. It is pleasant to think that while this is so, the Lyceum is filled nightly by audiences which crowd to do honour to the charming actress (in her own paths incomparable) who has visited us from America.

The Patents Department of the Bethnal Green Free Library is now open for the free use of the public daily from 11 a.m. till 3 p.m., and from 6 till 10 p.m. G. F. Hilcken, *Librarian.*

The following figures give the production of rails in 1883 as estimated:—United States, 1,303,000 tons, about 190,000 tons less than in 1882; Great Britain, 1,097,174 tons, about 140,000 tons less than in 1882. In looking into these figures it has to be borne in mind that the United States absorb the whole of their own produce, whereas Great Britain had to find outlets for 773,509 tons, the difference for home consumption being 323,665 tons.

The members of the Edinburgh Stock Exchange Association have forwarded a memorial to the Postmaster-General pointing out the inconvenience and loss resulting from the constantly recurring interruption of telegraphic communication caused by the frequent storms, and suggesting that at least the principal lines of communication throughout the country should be protected from atmospheric disturbance by wires being placed underground. It is not proposed that the underground system should supersede the present system. In ordinary circumstances it would act as an auxiliary, and in contingencies only as a substitute.

The number of railway carriages now being provided with improved means of lighting is larger than generally thought. The Pintsch's Patent Lighting Company has fitted on the Midland Railway 11 carriages, and has 84 in hand; for the Great Western they have fitted 30 carriages; for the South-Eastern 154 are fitted; for the Metropolitan, 257 fitted, and 60 in hand; for the District, 296 fitted, and 54 in hand; for the London and South-Western, 292 fitted, and 61 in hand; for the Great Eastern, 560 fitted, and 32 in hand; for the Caledonian, 102 fitted, and 40 in hand; for the Glasgow and South-Western, 100 fitted, and 100 in hand; for the North British, 2 fitted, and 24 in hand; making a total of 1,804 carriages fitted, and 456 in hand. But, of course, a total of 2,260 is small compared with the total number in use. It is, however, indicative of the spread of a much-needed improvement.

"Let Knowledge grow from more to more."—Alfred Tennyson.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the Editor of Knowledge; *all Business communications to the* Publishers, *at the Office, 74, Great Queen-street, W.C.* If this is not attended to delays arise for which the Editor is not responsible.

All Remittances, Cheques, and Post Office Orders should be made payable to Messrs. Wyman & Sons.

The Editor is not responsible for the opinions of correspondents.

No communications are answered by post, even though stamped and directed envelope be enclosed.

METEORIC DUST.

[1149]—On Saturday, March 1, after snow had fallen to a depth of 5½ in., the sky cleared, and then what had previously been a white landscape became a grey or sooty one. All over the peninsula of Roseneath (and apparently the whole valley of the Clyde) a meteoric dust shower had taken place.

On realising this fact, I was careful to try and obtain some. Filtration only resulted in the finely-divided dust passing through with the water. It then occurred to me to melt the snow, and evaporate the resulting water. This I did from half a square foot; then dried and weighed the residue, which turned the scale at two grains, or 8 tons 12 cwt. 3 qr. 17 lb. to the square mile!

On Monday we had another snow-storm, and at midnight a second shower of dust, but very slight. This time the dust had aggregated into little black flakes, which melted their way through the snow at once on falling (there being a general thaw at the time, but no rain), leaving tunnels about the size of crow-quills. Barometer, 30·05 at 90 ft. first fall; 29·6 rising at second. I enclose some of the dust, in which the metallic particles are quite visible.

One of the oldest inhabitants here remembers "the year of the black snow," when it fell black. This occurrence took place on March 20, 22, 1828.

On the evening of the 4th, we had another grand sunset, and the sun appeared to go down much more northerly than due at this time of year. After the clock-light shone out the light was quite red, as if seen through a haze. Lewis P. Muirhead.

THE EARTH'S DUST ENVELOPE.

[1150]—The article upon "Our Earth's Dust Envelope," by Prof. S. R. Langley, lately published in Knowledge, reminds me forcibly of the fact that some of the factors that contribute largely, if not principally, to this "Dust Envelope" are almost entirely overlooked.

That Prof. Langley and Mr. King should travel on the wings of the imagination to China for "loess" to beautify the atmosphere around Mount Whitney, while the Inyo desert lay glittering in sunshine at their feet, is to me simply marvellous. But, sir, more marvellous still are the feats attributed to the fierce Krakatoa. According to some of our authorities, that now famous mountain has been supplying us for months with the concrete materials for our magnificent sunsets. Now, Mr. Editor, why should we sweep the regions of space for cosmic dust, and why go the Straits of Sunda and Behring for volcanic ashes to colour our skies, when we can get all we want, and more, too, nearer home? Does not the great African desert suffice for all our wants? Why, then, should it be coldly overlooked in favour of its more sensational rivals? Surely Sahara cannot be so utterly insignificant as to be justly ignored in this matter.

As a landscape painter for the last thirty years I have closely studied atmospheric effects—sunrises and sunsets more particularly—and I can affirm that not a single year passes without similar displays, the only difference having been their less frequency. This being the case, I can have but little faith in cosmic dust, and still less in Krakatoa. Yet I am open to conviction, and I hope you

will kindly bring your greater knowledge to bear upon the more humble phase of a most fascinating subject. E. RAWSTORM.

[I have little to say, the subject being too difficult in my opinion to justify the hasty guesses thrown out. If Krakatoa were the cause of the recent displays, yet one would expect the same features though with less splendour and frequency to have been seen before, and even to be seen every year; for eruptions occur somewhere every year. Has Mr. Rawstorm considered the circumstances that the peculiar ejecta of Krakatoa have been found in European snow-falls? One finds it less easy to understand how Sahara dust could reach the enormous height at which the matter reflecting sunlight certainly has been, than to understand how volcanic dust once sent up there would be carried all over the earth.—R. P.]

"THE GREEN SUN" IN HANKOW.

[1151]—A phenomenon similar to the "green sun in India" (observed at Ceylon from the 9th to the 11th of September inclusive; from various portions of the Indian Ocean on the 10th and 13th; and at Trichinopoly, for some three weeks preceding Oct. 2) has been witnessed several times at Hankow; on Nov. 17 by the Rev. A. W. Nightingale, and on another occasion about the same time (date unrecorded) and again so recently as Dec. 29 by the Rev. G. John and Rev. A. Foster. On these occasions the sun shortly before setting was of a pale green tint, the colour deepening as the orb declined; then followed an exhibition of the glowing redness of the western and southern horizon which since the early part of December last has been observed from the sea-board far into the interior. In due time we shall learn from physicists whether these two remarkable phenomena are correlated or not. Mr. Proctor ascribes the green hue of the sun to absorption of the sun's colour, and Père Decheverens suggests that the fiery glow is due to cosmic dust—to a disintegrated comet. Whatever the cause or causes of these two coincident phenomena may be they present this distinguishing feature. The appearance of a distant conflagration just before sunrise, and after sunset, has now continued for three months; while the solar greenness has been only occasionally observed. Information from other parts of China respecting the "green sun" is a desideratum. D. J. MACGOWAN.

Hankow, 9th Jan.

FLIGHT OF A MISSILE.

[1152]—My friends and self desire to thank you for the trouble and expense you have taken on our behalf in solving the problem relating to the flight of a missile projected vertically, published in No. 88 and several following numbers of KNOWLEDGE. We experienced much difficulty with the problem, and could not arrive at any basis of agreement among ourselves, but now we are perfectly satisfied with your solution; but we would like to see the problem rigidly solved, keeping strictly to the elliptic path, without involving the parabola. I know it will be much more difficult, and that the westerly deviation will be practically the same, even then. There is a small circular segment between the base of the path traced out by the projectile (that is the chord) and the arc of the equator between the two sides of the projectile's path, which ought to be deducted when considering the equality of areas. The height of this segment amounts to about 53 feet. This, for so long a chord, will give a considerable arc to be deducted.

We should like to see the problem strictly solved, but must leave that to you. Already you have done much for us, and for which we thank you.

Wishing you prosperity with your journal, and trusting you are well, on behalf of my friends, N. P. LEE.

Port Adelaide, South Australia,
Feb. 1, 1884.

INVENTION OF THE TELEPHONE.

[1153]—"Cosmopolitan" has gone far away for the origin of the telephone. Fifty years ago I saw the same instrument sold in the streets in Kent by a vendor of children's toys, and bought one for a penny. It consisted of two elongated pill-boxes with a diaphragm of thin writing-paper attached to each other by 20 ft. of sewing cotton passed through the centre of each diaphragm, and then knotted. SERIATIM.

OPTICAL ILLUSION.

[1154]—The following case of persistent self-deception may be of interest:—I have remarkably accurate and clear sight, and a good perception of shades of colour, and yet *italic* printing always conveys to me the impression of being in *dark-green* ink. What makes it more strange is that I have done a good deal as an amateur printer, and yet the italic type which I inked with black ink always seemed to give the same dark-green impression.

I fancy that as a boy I got some notion of coloured ink into my head (probably from the coloured rubrics of the Prayer-book), and my eye still persists in deceiving me. C. W. BOURNE.

WILD FUCHSIA.

[1155]—Can any of your readers inform me if the fuchsia grows wild in any of our southern counties? I came across a specimen of the fuchsia, in bloom, and apparently growing wild, on the eastern bank of Helford River, during a tour round the Cornish coast, as late in the year as the first week in November, 1881.

The flower was of the ordinary red and purple type, but of a very small size. F. W. HALFPENNY.

THE "SPARKBROOK" NATIONAL.

[1156]—Mr. W. H. Watts requests me to say in KNOWLEDGE if I consider the above machine a good one. The *central-geared* "Sparkbrook" I consider one of the best roadsters made, but I do not place any value on the statement that the machine may be driven up a flight of stairs. It would be easy to make a machine which could be driven up a flight of stairs and down one, and yet be an almost worthless machine for general riding purposes.

Only this week I have heard of another frightful accident on one of the boasted stair-climbing machines. JOHN BROWNING.

March 13th.

"A KINDLY THOUGHT" (R. P.).

[1157]—TO MY FELLOW-READERS,—From the tenor of the remarks anent the change of size and price of KNOWLEDGE, it appears the proprietors fear they may lose a certain number of their old subscribers. It has occurred to me, that if all who derive pleasure from a perusal of the work—that is, that if *each one of us* were to purchase an extra copy of the next number issued, and carry it about with us for a week or more, introducing it to our fellow-travellers on the railway, to our friends in the counting-house and at home, we may not only nullify the expected secession from the list of subscribers, but materially increase the number of these, thus giving the Editor greater heart for his work, and ensuring the publishers a more profitable undertaking, as some compensation for the intellectual dish they weekly provide us with. D. C.

(A SUBSCRIBER FROM THE BEGINNING).

LETTERS RECEIVED AND SHORT ANSWERS.

FREE LANCE. Mr. Richards' address was given, but, following our usual custom, was not inserted. It is no case of Jack Robinson, Mr. Richards is well and widely known.—B. MCMILLAN. So sorry, but no deserter.—W. L. Like you I know of no such work.—J. H. COBBETT.—E. ROBINSON.—J. HARDING. They fancied the fire was not hot enough because it looked dull in the sun's light. Have never heard of any experiments by Mrs. Somerville, but Professor Tomlinson made some, and, as might have been expected, they proved decisively that the sun's rays exert no appreciable effect on combustion.—G. H. STYLES.—N. P. LEE.—W. REYNOLDS.—LEOPOLD WAGNER.—THETA.—J. R. CORDER.—S. ALSOP.—R. S. CALLCOTT. Fear there is no prospect of all my books being in the hands of one publisher. Nearly all are advertised in KNOWLEDGE.—J. B. LINDLEY.—W. SWANSTON.—BLACKBROUGH. Thanks.—T. P. BATTERSBY.—J. W.—A. MCD.—STUDENT.—F. W. J. C.—H. SMITH.—J. F. C.—J. FARRAR. There are mistakes in every thing. Patented proposition.—A. GILES.—L. P. MUIRHEAD.—W. F. COLLIS.—A. J. WOOLINER.—L. M.—A. D. TAYLOR. Thanks.—J. W. ROBERTSON. Thanks. Inquire of publishers.—J. H. HAYWOOD. From publishers.—D. C. Thanks for your very kind and encouraging letter.—M. T. H.—M. F. J. MANN.—FACIEBAT. Fear there is little encouragement to lecture where Jupiter is such a novelty. Such slips as you notice may generally be referred to carelessness somewhere; but thanks.—T. R. CLAPHAM. Thanks for pleasant greeting.—M. The ring reflection would not work, for the following reasons,—the rays from a point even on the axis of the cylinder of which the ring-surface is part would not be brought to a focus as in your figure, but diverge after leaving the reflecting surface.—V. CAVAN. Excuse delay in reply to your letter. There is a correction for clock-time. Have drawn a figure showing exactly how clock-time differs from sun-time throughout the year. Will presently find room for it.—HELEN A. KING. Many thanks for the lines on knowledge which shall certainly appear.—W. J. TRONTON. If the diameter of a circle is 1, the area of the circle is represented by one-fourth of the well-known ratio (I quote from memory Loisettically strengthened) 3·14159265358979323846264338 32, &c., &c. If the diagonal of a square is 1, the area of the square is represented by half

the square root of 2, that is half of 1·41421356237309504880168872 &c., &c.; but I see you did not ask for this: the area of a circle containing such a diagonal is as before one-fourth of 3·14159265 &c.—RUPERT SWINDELLS. The comet was surely not very resplendent. Here it was little more than just visible.—J. B. FINDLEY. (1) Fear your question as to the publishers of Dr. Hull's Geographical Charts did not reach Mr. Allen. (ii.) A refractor would suit you best; in fact, I think mirrors for refractors are not sold separately, whereas you can get object-glass and eye-pieces. But if you go in for making the whole telescope, I suppose a reflector would be the thing. Yet what you would want for figuring a mirror would cost more than a small telescope such as you probably require.—IGNORAMUS. The term "parabolic orbit" is perhaps not correct,—parabolic path would be better. For twinkling or scintillation see full answer this week.—THOMSON WALKER. Clay's work is published by Thos. De la Rue; Pole's by Longmans: have forgotten price, but both books are cheap.—E. ROBINSON. The subject does not come within our scope, which includes rather things testable by the telescope and polariscope, spectroscope and microscope.—G. H. STYLES. Have some maps for the southern hemisphere in preparation, but for the present they have to wait. To see such a halo the eyes must be on or very near the line from sun's centre to the object forming the shadow. In the case of your head this was so, but not in the case of your horse's head nor of your raised hat. If you saw the halo round your friend's head there would be a difficulty. But he saw that: you only saw your own halo.—J. W. ROBERTSON. Nearly all the old numbers can be obtained, but four or five are out of print.—M. F. J. MANN. Have you not overlooked the vertical plumb-line above the "bottomless pit" (as Professor Smyth considers the underground chamber to be)? That would give the horizontal north-and-south line.—D. L. A very kindly suggestion.—LEWIS P. MUIRHEAD. Levity was just what Newton so neatly got rid of. Attraction suffices to explain all the movements of the planets.—A. J. WOOLMER. The odds against throwing 2 sixes with 2 dice are 35 to 1. The betting man who after you had chanced to throw 2 sixes twice running, offered you £100 to £5 that you would not throw 2 sixes again, was not only a gambler, which is bad, but a swindler, which is worse. The fair odds were £175 to £5.—A BELIEVER. Thanks; but such narratives numerous.—T. PRESTON BATTERSBY. I should simply say that *obviously* the evil results of any such attempt to remove misery would far exceed the good. The death of one whose life is torture does, no doubt, in itself bring relief; but a system by which such results were deliberately brought about would bring much more misery than it would remove.—GROPER. The principal of Virtual Velocities would be more suitable as the subject of an article than of a short answer: will see about this. Thanks for very kindly letter.—STUDENT. I avoided instances lest I should inadvertently injure Prof. Loisette. I should find no difficulty in applying the system to all the subjects you mention. But I have been especially struck of late by the way in which, apart from its direct application, the system strengthens and develops the mind's retentive power. To give an example of an outside use of the method, I note,—Walking through Richmond four or five times only, I have found it easy to recollect the names of about 150 tradesmen, in the order of their shops, on one side of the road. But I could cite a number of really useful applications of the system as well as this mere illustration of its effectiveness.—T. W. H. Thanks for your thoughtful and suggestive letter, which Mr. Foster has read with extreme interest.—MARTHA HATHERWELL. The construction of telescopes so far as optical principles are concerned is dealt with in my little book "Half-hours with the Telescope," published by (and the property of) Messrs. Allen & Co.—R. H. ROCKE. I think my note of admiration only related to the "shape of an oyster-shell." The quantity of matter falling on the earth from outside can only be roughly estimated from the known mass of shooting stars, their number as observed at any given station and so forth.—A. MCD.—E. L. R.—C. W. BOURNE.—E. J. P.—(1.) No dictionary of astronomical, that I know of, gives the pronunciation of star names. (2.) Some animals like some music.—E. L. R. The original "blue stockings" was a gentleman—Mr. Stillingfleet—who showed such marked conversational power at meetings of literary ladies held in Johnson's time that they used to say when he was absent, "We can do nothing without our blue stockings" (he rejoiced in two legs). Hence these meetings came to be called "blue-stocking clubs," and the ladies who attended them were called "blue-stockings." "*A* blue-stocking" is absurd, unless a lady had a wooden leg.—G. H. WILKINSON. Thanks for kindly letter. For fear of giving Mr. N. C. excuse for further entry your quaint letter of denunciation does not appear.

ERRATUM.—I suppose I wrote "Skill at Chess" instead of "Skill at Whist" last week: but it was merciless of compositor and reader to leave it unchanged.

Our Mathematical Column.

NOTES ON EUCLID'S FIRST BOOK.

BY RICHARD A. PROCTOR.

(*Continued from page* 153.)

LET us nex examine the particular objects which Euclid appears to have had in view in the first book, and see whether any additions seem to be suggested; noting at the same time those propositions which are of frequent use to the geometrician.

The first proposition shows us how to construct an equilateral triangle. The same method is clearly applicable to the construction of an isosceles triangle on any finite line.

The student is not likely to neglect the application of Prop. 3 (to which Prop. 2 is wholly subsidiary).

Prop. 4 is the first determining the equality of triangles. The others are Props. 8 and 26. We learn from them that the equality (i) of two sides and the included angle; (ii) of the three sides, (iii) of two angles and a side opposite to equal angles in each triangle; or (iii) of two angles and a side adjacent to them suffices to determine the equality of two triangles *in all respects*. For although Euclid limits the proof in Prop. 8 to the angles contained by the *sides* (as distinguished from the *base*), yet since any side might have been taken for base the equality of each angle of one triangle to the corresponding angle of the other is established.

Now there are six elements in the determination of a triangle,—the three angles and the three sides. It will appear, on consideration, that Euclid has combined these, three and three, in four ways out of six possible ways. It remains, then, only to consider the remaining two.

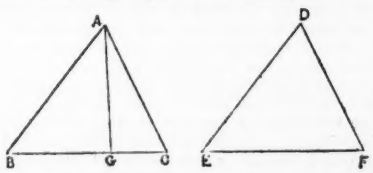
It is obvious that if the three angles of one triangle are equal to the three angles of another, the triangles are not necessarily equal. For, it follows from Euc. I., 29, that if we draw a parallel to one side of a triangle, either within the triangle, or else to meet the other two sides produced, we form another triangle, unequal to the first, but having equal angles.

There remains only the case of two triangles having two sides of the one equal to two sides of the other each to each, and an angle opposite one side of one triangle equal to the angle opposite to the equal side of the other. In this case the two triangles are not *necessarily* equal. We may form the following proposition, which is an important one, as are also its corollaries.

PROP. I.—*If two triangles have two sides of the one equal to two sides of the other, each to each, and the angles opposite to a pair of equal sides equal; then if the angles opposite the remaining sides be both acute, or both obtuse, or if one of them is a right angle, the two triangles are equal in every respect.*

In the two triangles A B C, D E F, let A B be equal to D E, and A C to D F; also let the angle B be equal to the angle E.

First let the remaining angles C and F be acute.



If the angle A be not equal to the angle D, make the angle B A G equal to the angle D. Then the triangles A B G and D E F are equal in all respects (Euc. I., 26), therefore A G is equal to D F, and the angle A G B to the angle F. But since D F is equal to A C, A G is equal to A C, and the angle A G C to the angle A C G; hence A G C is an acute angle and A G B obtuse (Euc. I., 13). Therefore the angle A G B is *not* equal to the angle F; which is absurd. Therefore the angle B A C is not unequal to D, that is, these angles are equal, and (Euc. I., 4) the triangles A B C and and D E F are equal in all respects.

If the angles C and F are both obtuse the proof is similar to the preceding; or if we please, we may adopt a proof resembling that of the following case.

If the angle C is a right angle, we proceed as before until we have proved that the angle A G C is equal to the angle A C G. Thus we have two angles of the triangle A G C equal to two right angles, which is impossible. Therefore, as before, the triangles are equal in all respects.

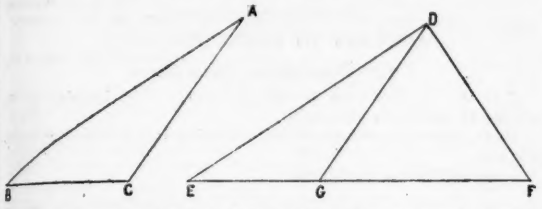
COR. 1.—If the equal angles B and E are right or obtuse, the other angles are necessarily acute and the triangles are equal in all respects.

COR. 2.—If the equal sides A C, D F, are greater than the equal sides A B, D E, the angles C and F are necessarily acute (Euc. I.

18, 17). Hence in this case also the triangles are equal in all respects.

SCHOLIUM.—It appears, then, that the triangles can only differ, when the equal angles B and E are acute, and the pair of sides opposite them less than the other pair of equal sides. In this case a relation holds important enough to form a separate proposition—of which we shall presently have occasion to make use,—

PROP. II.—*If two triangles have two sides of one equal to two sides of the other, each to each, and the angles opposite one pair of equal sides equal; then if the angles opposite the remaining pair of equal sides be unequal their sum is equal to two right angles.*



In the triangles A B C, D E F, let A B, A C, be equal to D E, D F, each to each; the angle B equal to the angle E, but the angle C greater than the angle F,—so that by Prop. I. C is obtuse and F acute. Then (Euc. I. 32) the angle E D F is greater than A. Make the angle E D G equal to A; then the triangle E D G is equal to the triangle A B C in all respects (Euc. I. 26). Hence D G is equal to A C, and therefore to D F; also the angle D G E is equal to the angle C. Now since D G is equal to D F, the angle D G F is equal to the angle D F G. But D G F and D G E together make up two right angles; hence their respective equals F and C together make up two right angles.

COR. 1.—The triangle E D F exceeds the triangle A B C by the isosceles triangle D G F.

There are other elements such as the area, altitude, and so on, which determine triangles. We shall have occasion, as we proceed, to notice how triangles may be constructed when one or more such elements, combined perhaps with one or more of the six elements just considered, are given. But we may consider the relations discussed in Euc. I., 4, 8, 26, and in the above propositions, as the fundamental problems in the determination of triangles.

We proceed, therefore, to discuss the construction of triangles when certain of the six elements above considered are given.

(*To be continued*).

EASY RIDERS ON EUCLID'S FIRST BOOK.

WITH SUGGESTIONS FOR SOLUTION.

PROP. 6.

15. In the figure of I. 5, if F C, B G meet in H, the triangle B H C is isosceles.

16. If, further, F G is drawn, the triangle F H G is isosceles.

17. If, further, A H be drawn, the triangles A B H, A C H, are equal in all respects.

18. With the same construction A H bisects B C at right angles.

19. With the same construction A H produced bisects F C at right angles.

20. With the same construction the triangles B H F, C H G are equal in all respects.

If problems 15–20 be taken in order, the student will find no difficulty in solving them without using any propositions beyond Euc. I., 6.

21. If the angles A B C, A C B at the base of an isosceles triangle be bisected, by the straight lines B D, C D, show that D B C will be an isosceles triangle.

22. In the quadrilateral A B C D, D C is equal to B C, and the angle A B C is equal to the angle A D C. Show that A D is equal to A B.

Join D B *and apply Euc. I. 5; the rest is obvious.*

(*To be continued.*)

CANADIAN TELEGRAPHS.—A Canadian Blue Book just issued says that Canadian tariffs are probably the cheapest in the world, and will still compare favourably with the reduced rate of sixpence shortly (?) to take effect in England.

Our Whist Column.

BY "FIVE OF CLUBS."

THE following game illustrates the importance of clearing or helping to clear your own or partner's strong suit: *Y* who plays badly throughout negects this rule, *B* follows it and wins thereby five by cards.

THE HANDS.

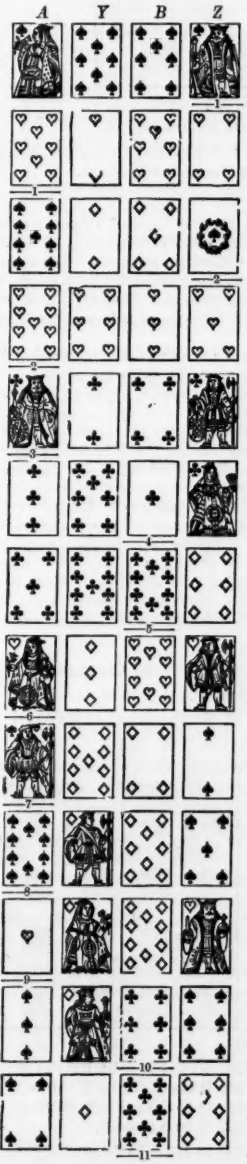
B: *Clubs*—A, 10, 8, 6, 4. Hearts—10, 7, 3. Spades—7. Diamonds—10, 8, 5, 4.

Y: *Clubs*—9, 7, 2. Hearts—6, 2. Spades—8. [3, 2. Dia.—A, K, Q, Kn, 9,

A B, 0. **B** Dealer. **Z** *Trump.* *C.* Q. Leader. **A** *Y Z*, 0.

Z: Q, Kn—*Clubs*. 4, 5, Kn, K—Hearts. 2, 5, 6, K, A—Spades. 6, 7—Diamonds.

A: *Clubs*—K, 5, 3. Hearts—A, Q, 9, 8. Spades—Q, Kn, 10, 9, 4, 3. Diamonds—None.



NOTES AND INFERENCES.

1. All know that *A* holds Kn, 10. Position of 9 remains unknown to all except *A*. *A* knows that *Y* and *B* have no more Spades, unless one or other is signalling.

2. *A* sees that *Y* has not been signalling, unless—which is unlikely—he held originally but two Spades, and a singleton in Hearts. *B* may be signalling. *B* knows that honours in Hearts are divided between *A* and *Z*.

3. *A* leads the 9 in order that his partner may know what *Z* already knows, that *A* holds quart minor. *Y* should have trumped even if he had been certain *Z* held the Ace. Why, discarding, he selected his splendid Diamond suit it is impossible to divine. He may have had some vague idea of keeping a card wherewith to return his partner's suit. But he should have seen how much better was the chance of bringing in his own suit after ruffing. *B* who *is* certain that *Z* holds the Ace, very properly declines to ruff, that his partner's suit may be cleared. He sees further that *Z* will lead at a disadvantage. He commences another signal.

4. *Z* would probably have led a Diamond, his partner being so weak in Hearts, but for *Y*'s discard. *B* sees that *A* holds Heart Ace. *B* completes his signal. *Y* holds now only Diamonds and trumps.

5, 6, 7. *A* responds to his partner's signal and the enemy's teeth are carefully extracted.

8. *B* gives his partner the lead, and

9, 10, 11, 12, 13, the rest of the hand plays itself, *A*-*B* making five by tricks.

DOUBLE DUMMY ENDING.

BY MR. F. H. LEWIS.

A.—S. A, 2; D. A, 6, 4; H. K, 10.

Y.—S. 9, Q; D. Q, K; C. 9; H. 6, Q.

B.—S. 10, K; C. 5, 10; H. 3; D. 7, 10.

Z.—S. 3, 8; H. 4, 8; C. Kn; D. 5, 8.

Spades trumps. *B* to lead, and *A* and *B* to make all seven tricks.

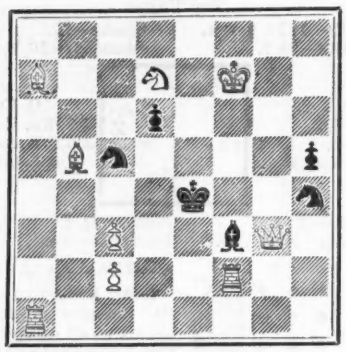
Our Chess Column.

By MEPHISTO.

PROBLEM No. 115.

By E. N. FRANKENSTEIN.

BLACK.



WHITE.

White to play and mate in two moves.

NOTE.—We offer a copy of Miles's "Poems and Chess Problems" for the first best solution received of the above problem.

IF we had to write a dissertation on the uses of Chess, we feel confident we should point out many beneficial effects of Chess playing which escape the notice of ordinary observers. We should likewise suggest many occasions when a game of Chess might be played to afford recreation and amusement. We must, however, confess that we should never have thought of advocating Chess play on 'Change.

But truth is stranger than fiction, for that which our imagination would have refused to depict has actually come to pass. Two gentlemen have whiled away time "in the house" by playing Chess *blindfold*.

We cannot tell whether or no blindfold Chess play—as strengthening the mind—was resorted to as an indirect aid to devise clever means to raise the price of "Unified," or whether, by increased powers of analysis, the players hoped to be better able to estimate the proper value of "Grand Trunks" and "American" Rails, in order to avoid the snares, pitfalls, and delusions of the Vanderbilts, Goulds, &c. It is sufficient for our purpose to state that, considering the strength of the players, they played a really good game, notwithstanding the necessarily trying surroundings. We append the score of the game, and although some weak moves occur this is fully condoned by the brilliant finish, where White announces a mate in four moves.

GAME PLAYED BLINDFOLD ON THE STOCK EXCHANGE.

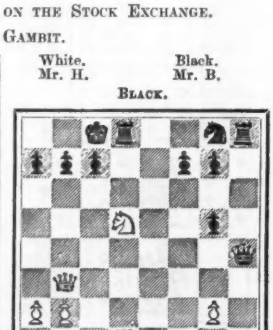
CENTRE GAMBIT.

White. Mr. H.	Black. Mr. B.
1. P to K4	P to K4
2. P to Q4	P takes P
3. P to QB3	P takes P
4. B to QB4	P to Q3
5. Q to Kt3	Q to K2
6. Kt takes P	Kt to QB3
7. Kt to B3	B to K3 (?)
8. B to KKt5	B takes B
9. Q takes B	Q to Q2
10. Castles KR	B to K2
11. P to KR4	B takes B
12. Kt takes B	Kt to K4
13. Q to Kt3	Castles
14. P to B4	P to KR3
15. P takes Kt	P takes Kt
16. P takes QP	Q takes P
17. QR to Q sq.	Q to K2
18. Kt to Q5 (!)	Q takes P
19. KR to K sq. (!)	Q takes RP

White announced mate in four moves.

White. Mr. H.	Black. Mr. B.

BLACK.



WHITE.

20. Kt to Kt6 (ch)	RP tks Kt (*a*)
21. R tks R (ch)	K takes R
22. Q to Q5 (ch)	K to B sq.
23. R to K8 mate.	

(*a*) If 20. BP takes Kt, then 21. Q to B3 (ch) &c.

SOMETHING BETWEEN FOOL'S MATE AND SCHOLAR'S MATE.

EVERYONE knows Fool's Mate in which mate is given by second player on the second move, and everyone knows Scholar's Mate in which mate is given by first player on the fourth move. But perhaps everyone does not know the following mate in three, in which there is a combination of energy in attack and self-sacrifice in defence, entitling us to regard this mate as "something between Fool's and Scholar's."

1. P to K4	1. P to K4
2. Q to R5	2. K to K2
3. Q takes P mate	

[R. P.]

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

J. G. W.—1. The book is out of print. Try Long's. 2. No chance of coming to life again.

H. W. Sherrard.—Received with thanks, but *four* are too many for us.

Tom.—Problem not suitable.

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The following arrangements are complete: the numbers in brackets referring to above list.

LONDON (Brixton Hall) March 28, April 1, 4, 8 (1, 2, 3, 4).
" (Memorial Hall), March 24, 27, 31, April 3 (1, 2, 3, 4).
CRYSTAL PALACE, April 7, 9 (1, 3).
GRAVESEND, March 25, 26 (1, 2).
ST. LEONARDS, March 29 (Afternoon); April 2 (Afternoon and Evening).
BIRMINGHAM (Town Hall), April 18, 23, 25, 28; May 2 (1, 2, 3, 5, 6).
LEAMINGTON (Royal Music Hall), Four Afternoons, April 17, 19, 24, 26 (1, 3, 5, 6); Two Evenings, April 17, 24 (2, 4).
St. HELEN'S (Lanc.), April 22 (2).
COVENTRY, April 30, May 1 (1, 2).
MALVERN, May 3, 17 (Afternoon) (2, 3).
LLANELLY, May 5 (1).
SWANSEA, May 6, 7 (1, 2).
WORCESTER, May 8, 9, 15, 16.
BANBURY, May 14 (Afternoon and Evening).
OXFORD, May 12, 13, 19, 20.
CAMBRIDGE, May 21, 22, 23.

NOTE.—*All communications respecting Lectures should be addressed to Mr. John Stuart, Royal Concert Hall, St. Leonards.*